(Established 1832.)
AMERICAN ENGINEER AND RAILROAD JOURNAL

MARCH, 1906.

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# EAST ALTOONA FREIGHT LOCOMOTIVE TERMINAL.

PENNSYLVANIA RAILROAD.

II.

### ROUNDHOUSE.

The roundhouse is in the form of a complete circle, and has 52 divisions, or stalls, 90 ft. deep; two of these divisions are used for a passageway through the house (Fig. 1, page 46). These passageways are in the form of tunnels, have brick walls, and divide the inside of the house into two parts. The foundations of the house are of concrete, the walls are of brick with a steel frame, and the roof is supported by steel trusses and a row of columns 25 ft. from the outer wall. Four-ply slag roofing is laid on 2-in. T and G white pine. The distance from the center of the turntable to the center of the outside row of columns is 197 ft. 7⅞ ins., and the diameter over the foundations is 396 ft. 11¾ ins. The distance between the centers of the columns of the inner wall is 13 ft. and of the outer wall 23 ft. 10⅜ ins.

The construction of the building is clearly shown by the cross section, Fig. 19. This cross section is quite different from that of any other roundhouse previously constructed, although the locomotive heads outward, as is the usual custom. It was the intention to have a 12½-ton travelling crane on a circular runway serve the main or inner portion of the house, which is 65 ft. wide. This crane, which was to have a span of about 62 ft., has never been installed, although it can readily be added by erecting the supplementary crane columns, as shown in the drawing. The use of the crane made necessary a height of 30 ft. from the floor to the underside of the roof trusses, and this large amount of head room and the lantern at the center of this portion of the roof provide splendid ventilation. As a very large portion of the side walls is of glass, as shown in Figs. 17 and 18, the daylighting is excellent.

The outer part of the house is 25 ft. wide from center to center of the columns, and measures only 18 ft. from the floor to the underside of the roof trusses. While it is of rather unusual design to have the locomotive's front end under the lowest part of the house, yet the very efficient form of smokejack which is used makes it possible to keep the house comparatively free of smoke. The front end of the locomotive is served by a screw hoist jib crane of 2,000 lbs. capacity, 12 ft. 6 ins. long.

SMOKEJACKS.—The smokejacks, shown in detail in Fig. 20, are of a special form, which has been developed by the railroad after considerable experiment, and are very efficient. They are made of Vitribestos, and were furnished by Paul Dickinson, of Chicago. This material is very light, the moisture does not readily gather upon it, and it is expected that its wearing qualities will prove very satisfactory, although these jacks have not been in service long enough to determine this definitely. The Vitribestos is laid over a framework of 2½ by 2½ by ¼-in. angles, as shown. The opening at the mouth of the jack is 7 ft. long and 3 ft. 1 in. wide, and this tapers to a circle of 3 ft. 1 in. diameter at the roof, or 11 ft. 6 ins. from the mouth of the jack. If the locomotive stops with its stack under one end of this opening the smoke passes off readily and is not deflected downward into the house, as has been the case with broad-mouthed stacks with sharper slopes. The method of carrying the jacks through the roof is an especially good one, as may be seen by reference to the drawing.

ENGINE PITS AND HEATING DUCT.—The cross section of one of the engine pits is shown in Fig. 21. They are 65 ft. long, 3 ft. 11 ins. wide, 2 ft. 6 ins. deep at the front end and 3 ft. deep at the rear end. The front end of the pit is 16 ft. from the outer wall of the house. The walls and the bottoms of the pits are of concrete; the rails are supported on 8 by 12 in. white oak timbers.

The roundhouse is heated by hot air furnished by the Sturtevant system. A hot air duct or tunnel leads from the fan house around the house, just inside of the outer wall. Hot air from this duct enters each pit at the front end and is forced up underneath the engine; there is another opening in the side of each pit at about where the middle of the tender ordinarily stands. The heating duct is 6 ft. wide and 7 ft. 6 ins. deep at its maximum section, and decreases in height as it gets farther away from the fan house. This tunnel also carries all the piping for the roundhouse, which includes a 4 in. pipe for the fire service, a 4-in. pipe for cold water at 100 lbs. pressure, a 3-in. pipe for compressed air, a 4-in. pipe for hot water at 300 lbs. pressure and a 4-in. steam pipe. Between every other engine pit are water, steam and air connections. The hot water at 300 lbs. pressure is used for testing and washing out the boilers. A boiler can be filled with this hot water in 4½ minutes. Connections are placed in each pit so that the engines can blow off into the sewer outside of the house. Half-way between the pits and at a point 6 ft. to the rear of the middle row of columns the floor level is 3 ins. above the top of the rail, and from this point it slopes toward each pit and to meet the level floor at each end of the pits. This part of the floor consists of 2¾-in. yellow pine laid on 4 by 6-in. stringers, resting on ballast and spaced 14 ins. center to center.

A simple and very efficient cast steel track stop, details of which are shown in Fig. 22, is used at the ends of the tracks so that there will be no possibility of the locomotive moving too far forward and breaking through the floor into the hot air

FIG. 17.—PART OF THE ROUNDHOUSE WITH THE OFFICE BUILDING, POWER PLANT, FAN HOUSE AND OIL HOUSE TO THE RIGHT (FAN HOUSE HAS SINCE BEEN CONNECTED TO THE ROUNDHOUSE.)

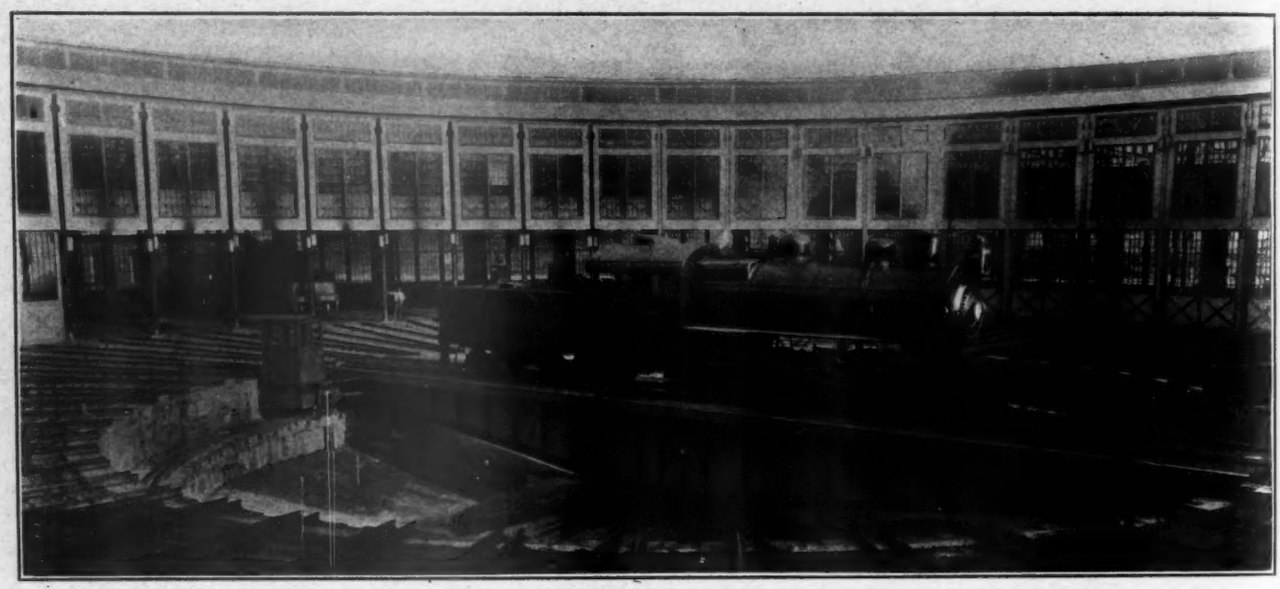


FIG. 18.—100-FOOT TURNTABLE.

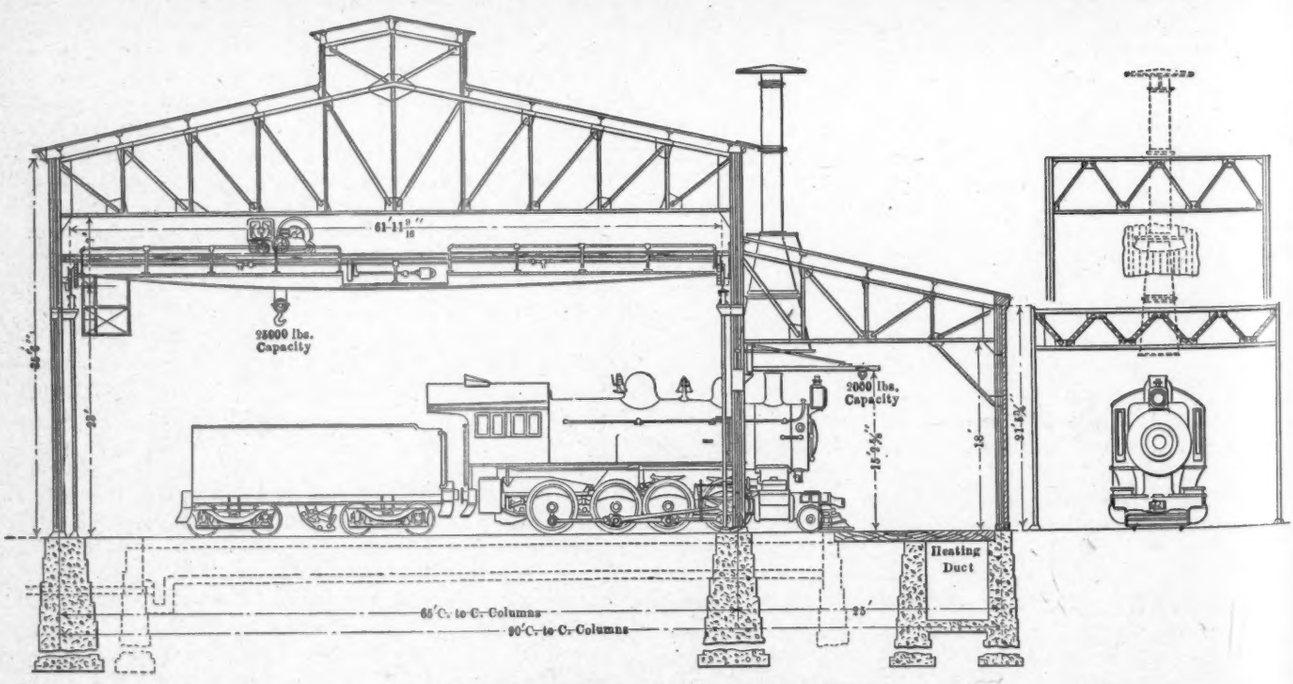



FIG. 19.—CROSS-SECTION THROUGH THE ROUNDHOUSE.

EAST ALTOONA LOCOMOTIVE TERMINAL.

duct. As the minimum distance from the top of the rail to the underside of the pilot is only about 3 ins., and as it is necessary to have the stop at least 5½ ins. high, so that the wheel cannot climb over it, the top of the body of the stop must be made considerably lower than the top of the rail so that the pilot will pass over the highest point.

DROP TABLES.—Four of the pits near the main entrance of the roundhouse and to the machine shop are equipped with drop tables. One of these is 55 ft. long, for use when it is

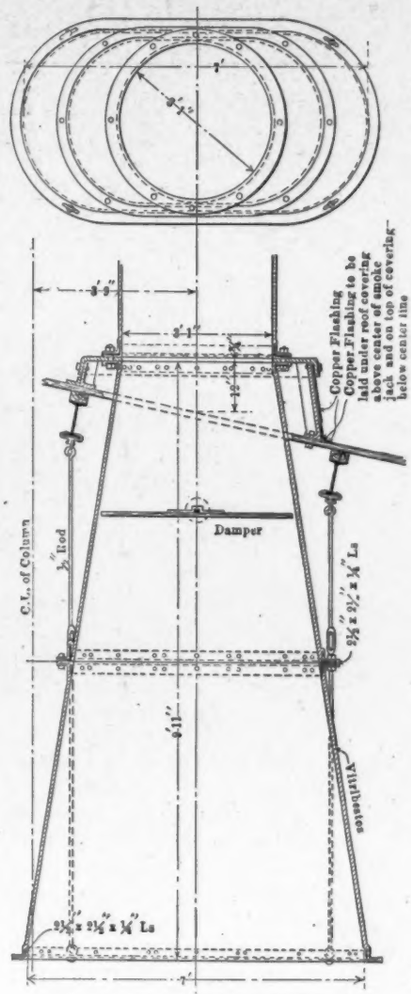

Copper Flashing
Copper Flashing to be laid under roof covering above center of smoke jack and on top of covering below center line
Damper
½" Rod
C.L. of Column
2½" x 2½" x ¼" Ls
Ventilator
2½" x 2½" x ¼" Ls

FIG. 20.—SMOKEJACK.

desired to remove a set of driving wheels; one is 24 ft. long for engine truck wheels, and two are double drops, each 8 ft. 6 ins. long, for a single pair of driving wheels. The arrangement of the drop tables for a single pair of driving wheels is shown in Figs. 23 and 24; the driving mechanism is practically the same as for the other tables. The driving wheels are lowered by the rear table until they are level with the track in the pit, they are then rolled forward to the other table and are raised to the surface. A 27-h.p., 220-volt General Electric motor drives the two long shafts, which are supported by adjustable bearings and to which the worms are keyed. Each table is operated by four vertical screws, two right and two left hand. The motor speed is 480 r.p.m., the ratio between the worm and the worm wheel 20 to 1, the pitch of the screw is 1½ ins., and the movement of the table vertically is at the rate of 2 ft. per minute. As the tables are lowered the vertical screws pass down into the pieces of 7-in. pipe which are capped at the lower end and are filled with oil, thus lubricating the screws. These 7-in. pipes are encased in 10-in. pipes set into the concrete. The worm wheels run on roller bearings, and these are carried on center plates with ball joints, so that the screws will not be injured by any side or end movement of the table.

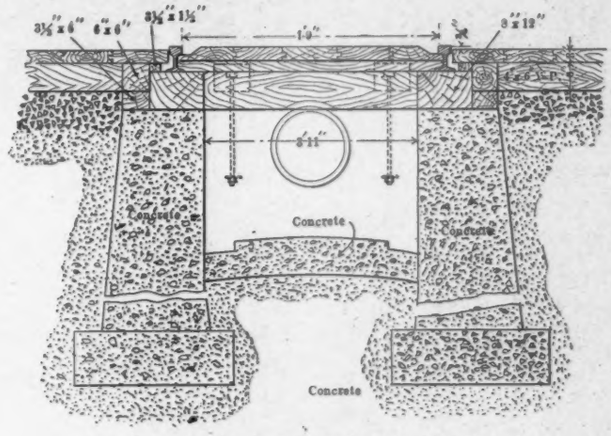



FIG. 21.—CROSS-SECTION THROUGH ENGINE PIT.

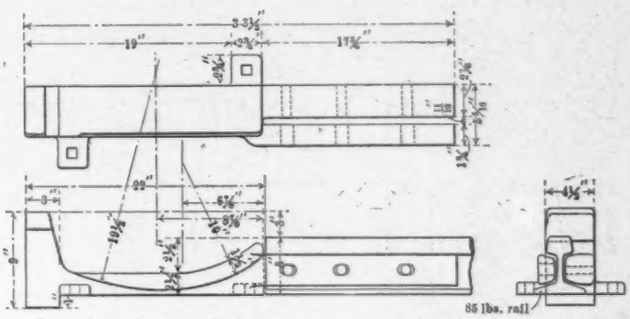



FIG. 22.—CAST STEEL TRACK STOP.

DOORS.—The roundhouse doors are of wood, about 60 per cent. of their area being glass, and they are raised by 4-in. pneumatic hoists with a 16 ft. 5-in. stroke; they are lowered by gravity, the exhaust from the air cylinders being such that they will not drop too fast.

LIGHTING AND HEATING.—Direct current 100-volt arc lamps are used, and in addition each one of the columns in the middle row is equipped with connections for incandescent lights, which may be carried to any part of the engine. The house is heated by the Sturtevant hot air system, the hot air entering the engine pits as described above. An addition to the roundhouse contains two Sturtevant fans, each 12 ft. in diameter by 16 ft. wide, driven by 11½x16-in. engines. These fans draw through two heaters having a combined surface equivalent to

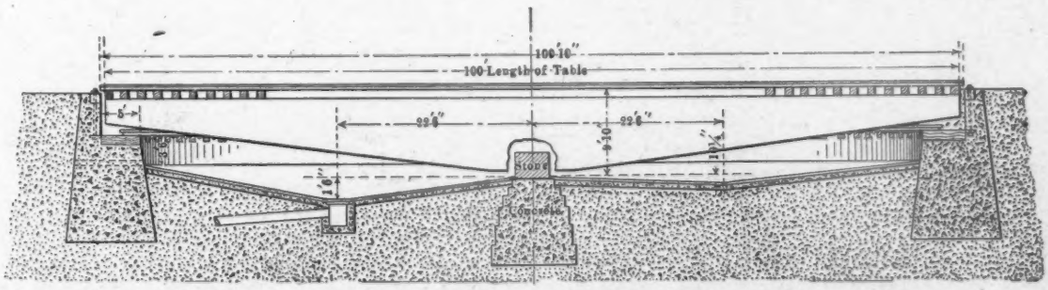



FIG. 25.—TURNTABLE AND PIT.

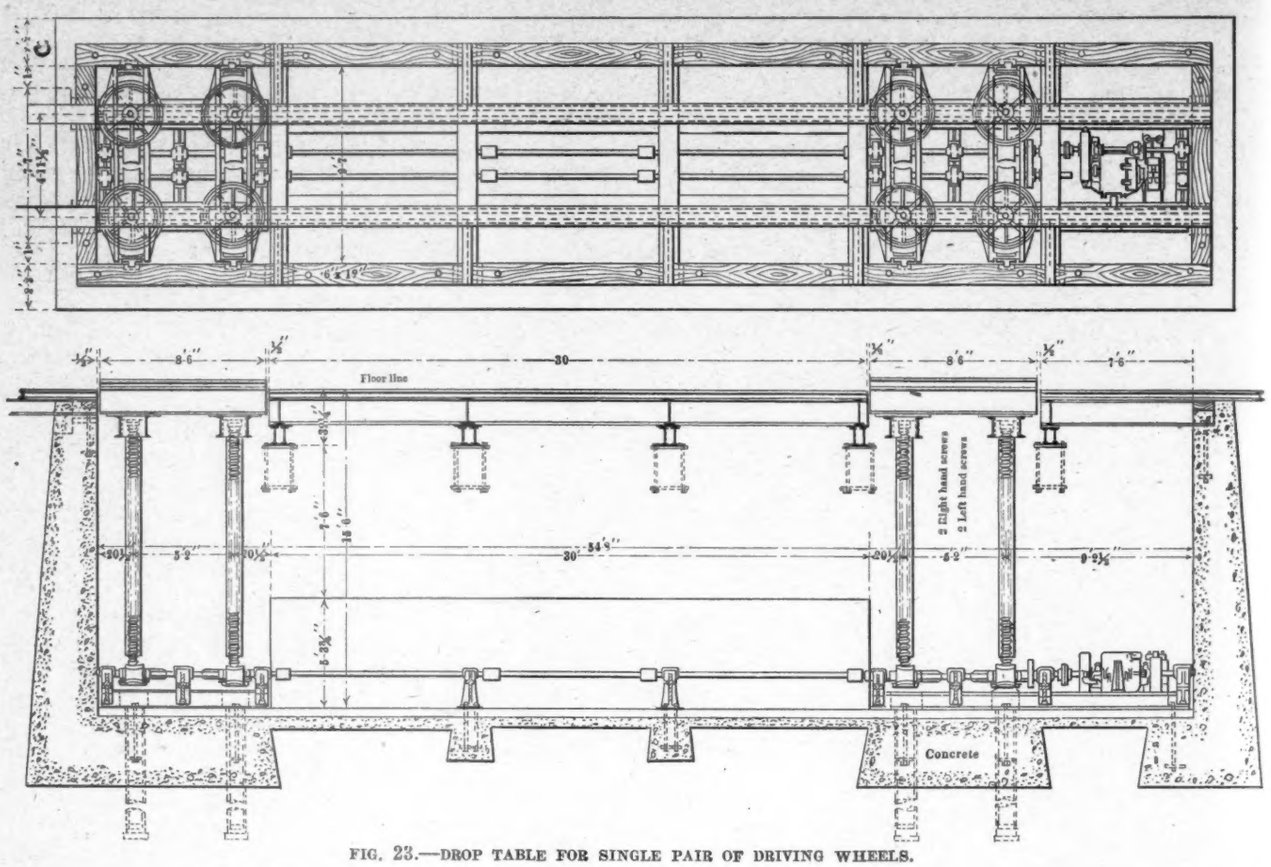



FIG. 23.—DROP TABLE FOR SINGLE PAIR OF DRIVING WHEELS.

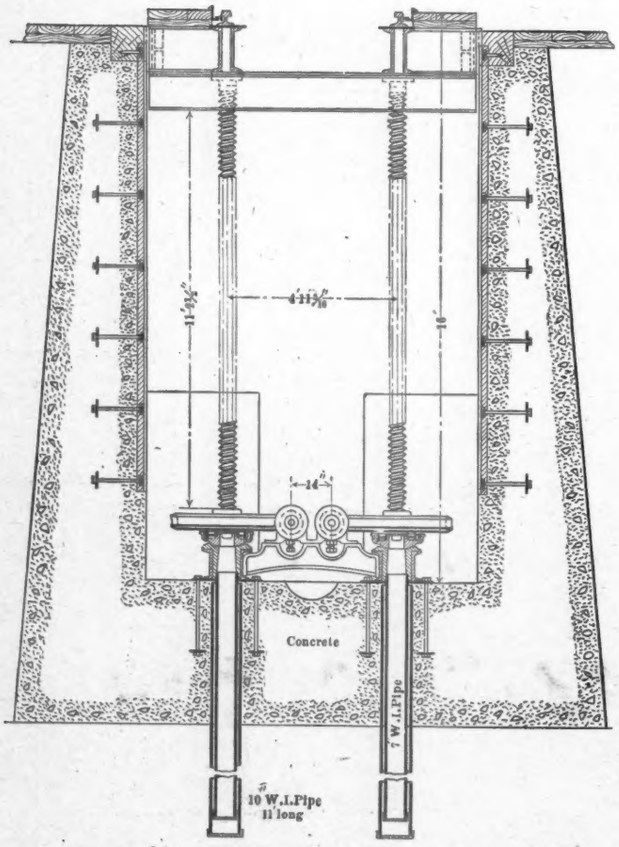



FIG. 24.—CROSS-SECTION OF DROP TABLE PIT.

over 26,000 lineal ft. of 1-in. pipe. The apparatus is designed to change the air in the roundhouse in from 18 to 20 minutes.

The fan house also contains a well 8 ft. in diameter and 24 ft. deep, which drains the heating duct. The water is pumped from this well through a 6-in. discharge pipe into the sewer by means of two centrifugal pumps, which are submerged and are driven by 5-h.p. vertical type motors at the top of the well; these motors operate automatically.

TURNTABLE.—The turntable is 100 ft. in diameter, and is driven by a 12½-h.p., 220-volt General Electric motor. A very important feature of this table is the provision made for the drainage of the pit, which is clearly shown on the cross section of the pit, Fig. 25. The floor of the pit is of brick, laid flat on 6 ins. of concrete, and it slopes downward both from the outer edge and from the center, the lowest point being 22 ft. 6 ins. from the center. The pit is made deep enough, so that a large amount of snow and ice may accumulate without affecting the working of the table. The water is drained off through a 10-in. pipe.

### MACHINE SHOP.

The machine shop building, which also includes the flue and smith shops, is 67 ft. 10 ins. by 160 ft. 7 ins. The building has concrete foundations, brick walls with a steel frame, and the roof is supported by steel trusses and columns, as shown in Fig. 26. A 7½-ton electric travelling crane serves the middle bay of the shop. Forty-eight feet at one end of the building is partitioned off from the main shop, and one-half is used for the flue shop and the other half for the smith shop.

On each side of the machine shop there is a 20-h.p. electric motor mounted above the roof trusses, which drives the lighter machinery. Two universal radial drills and two wheel lathes are driven by individual motors. The equipment in the machine shop includes two driving wheel lathes, one of which is used exclusively for turning journals, a planer, shaper, slotter, vertical boring mill, two horizontal boring mills, seven engine lathes, three vertical drills, three universal radial drills, a hydraulic press, bolt cutter, pipe cutter and tool and drill grinders. The smith shop equipment includes a steam hammer and a large double forge. The flue department contains a full set of machinery for repairing and testing flues, and a flue rattler is located just outside of the shop.

### POWER HOUSE.

The power house is a steel frame brick building, about 65 ft.

square. It is divided by a 12-in. brick wall into an engine room 22 ft. 10 ins. by 62 ft. 3 ins., and a boiler room 38 ft. 11 ins. by 62 ft. 3 ins. The engine room floor is 6 ins. above and the boiler room floor 7 ft. below the ground level, as shown in the cross section, Fig. 29. The boiler equipment consists of six 60-in. locomotive type boilers, with a total capacity of about 1,000 h. p. Coal is unloaded from hopper cars

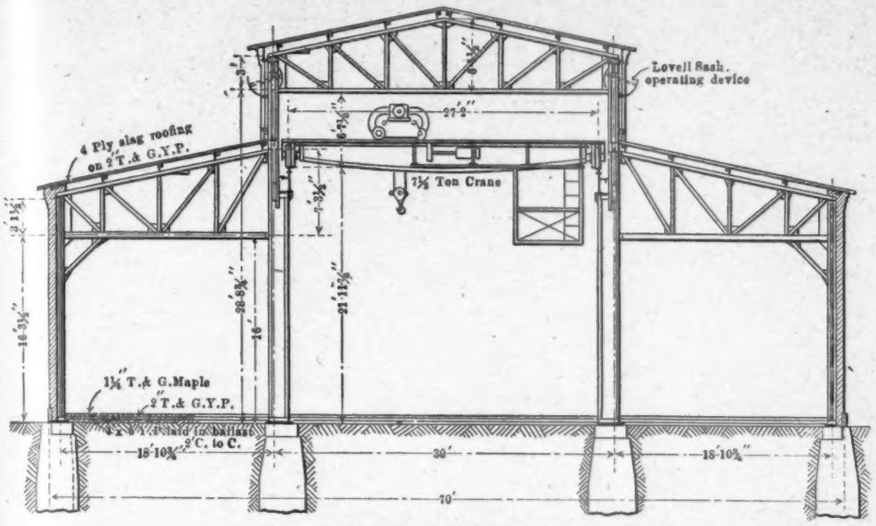



FIG. 26.—CROSS-SECTION THROUGH MACHINE SHOP.

on the trestle directly on to the boiler room floor. When sufficient ashes have accumulated in the pits they are raked into the ash buckets, which are similar to the one illustrated in Fig. 8, page 48. These buckets are run along a larry track to the outside of the building, where they are unloaded into a car on the siding by means of a pneumatic hoist on a runway which extends out over the track. Supported on a steel frame, above the boilers, is a large tank of 6,000 gal. capacity, which holds the hot water for testing and washing out the boilers and for other purposes. A Cochrane No. 28 special feed water heater supplies this large tank and also the boilers with water at 200 degs. F. There are two 10 by 6 by 10-in. Worthington boiler feed pumps. Two Knowles 8 by 12 by 12-in. vacuum pumps are used in connection with the Webster vacuum return system used with the Sturtevant heating system. The chimney is steel, brick-lined, 6 ft. in diameter and 120 ft. high.

In the engine room are two 11 by 19 by 14-in. tandem compound Ball engines, which are direct connected to 100-k.w., 225-volt General Electric generators. Compressed air at 100 lbs. pressure is furnished by two Ingersoll-Sergeant Class H two stage compressors, with 12 by 12-in. steam and 12 by 18 by 12-in. air cylinders. These are equipped with a water aftercooler, and the air also passes through an atmospheric aftercooler just outside of the house at one end of the engine room. There are two 17 by 18½ by 15-in. Worthington pumps, one of them being used in connection with an accumulator weighted for 300 lbs. pressure (hot water), and the other one is weighted for 100 lbs. pressure. These accumulators have 12-in. plungers and a 10-ft. stroke.

OIL HOUSE.

A transverse section of the oil house is shown in Fig. 30. The basement, 32 by 43 ft., has concrete walls and floor. It contains four 80 barrel oil tanks and six small ones. Oil from the tank cars is delivered to the storage tanks by gravity. The first floor is of expanded metal and concrete, designed for a pressure of 250 lbs. per sq. ft., and supported by I beams and cast iron columns. The upper part of the building is divided into three parts, a sweat room, 17 ft. by 21 ft. 10 ins., which is separated from the other part of the building by a 9-in. brick wall, a waste room 12 ft. by 21 ft. 10 ins., and separated from this by a corrugated steel partition is a drawing room 14 ft. 2 ins. by 21 ft. 10 ins. Oil is drawn from the tanks in the basement by means of compressed air. The roof of the building is of expanded metal and concrete, with a slag finish, and is supported by 8-in. I beams extending lengthwise on the roof trusses.

CLOSET AND LOCKER ROOM.

A brick building, 24 by 106 ft., just outside of the roundhouse and near the machine shop, contains closets, lockers and wash basins for the use of the men employed in the roundhouse and shops. There are one hundred and seventy-five 12 by 12 by 60-in. wire lockers, made by the Wayne Iron Works, and 70 large wash bowls supported by an open steel framework, so that dirt cannot accumulate underneath without be-

FIG. 27.—POWER HOUSE.

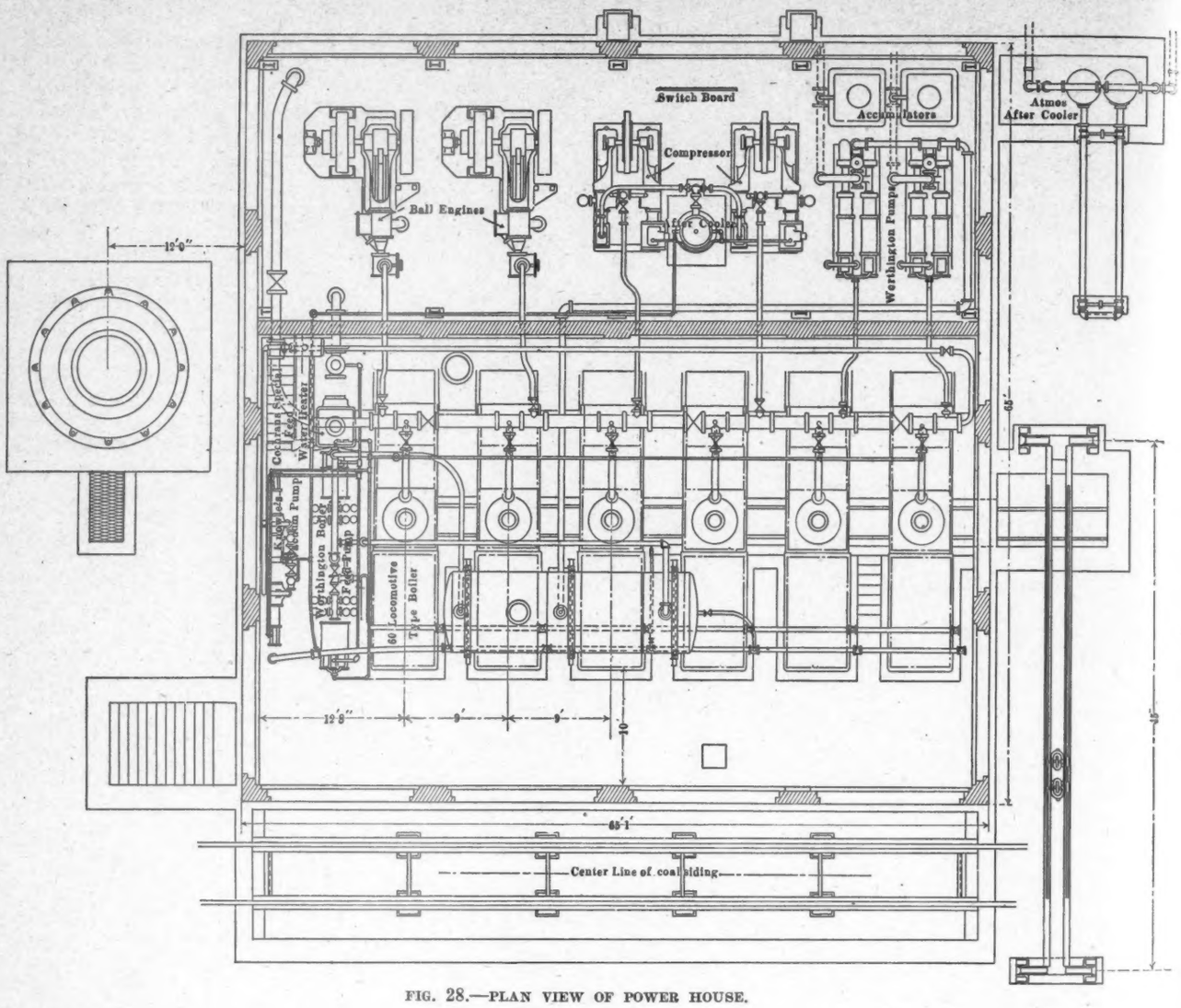



FIG. 28.—PLAN VIEW OF POWER HOUSE.

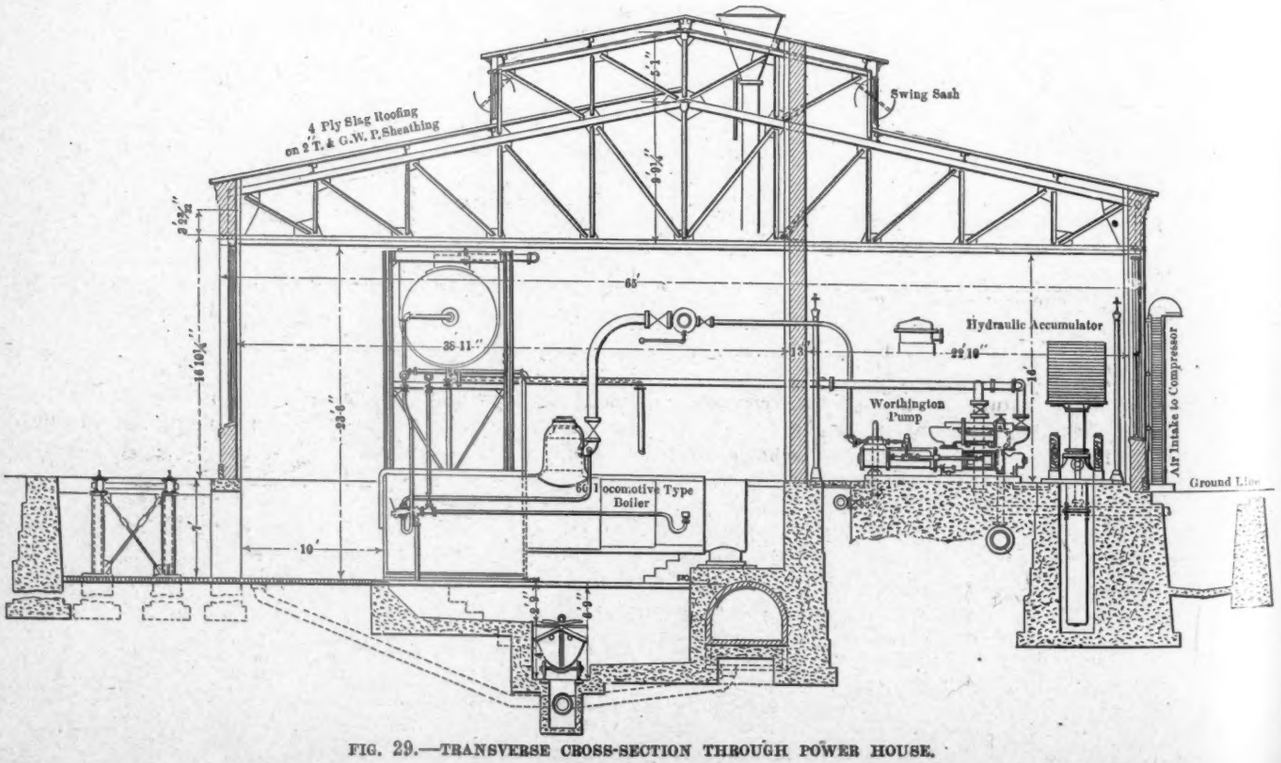



FIG. 29.—TRANSVERSE CROSS-SECTION THROUGH POWER HOUSE.

ing readily detected. The foundations of the building are of concrete and the floor is of reinforced concrete 8½ ins. thick, to prevent the floor from cracking in case the ground should settle, as the building rests entirely on filled ground. The roof is supported by light steel trusses.

OFFICE AND STOREHOUSE BUILDING.

A large two-story building, 65 by 161 ft., is used for the offices and storehouse, and the second floor is entirely devoted to the comfort of the engine crews who lay over at East Altoona. The basement has a clear height of 8 ft. 6 ins., has a concrete floor, and is used for the storage of heavy goods. An elevator connects it with the first floor. About three-fifths of the first floor is used as a store room, and the rest is divided into offices for the roundhouse foreman, the engine dispatcher and the road foremen of engines. The second floor contains an airbrake instruction room, 52 by 26 ft., a reading room, 44 by 26 ft., a bathroom, closets and nine bunk rooms containing 74 beds.

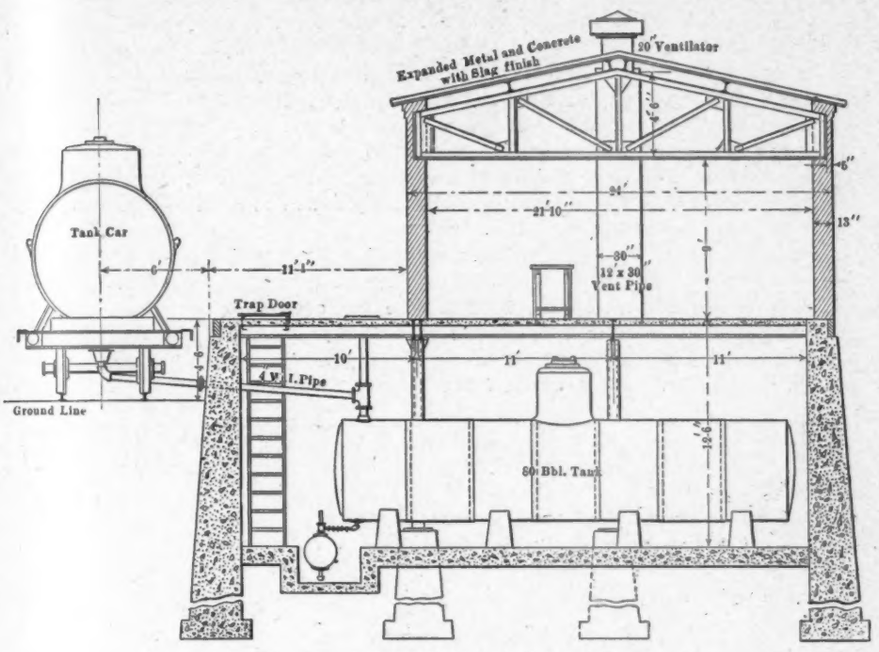



FIG. 30.—CROSS-SECTION THROUGH OIL HOUSE.

## RAILROAD EDUCATION.

In a paper on the above subject, read before the St. Louis Railway Club, Prof. Dewsnup of the University of Chicago gives in detail the work which could be accomplished by a Railway College forming part of one of the larger universities. In speaking on the subject he makes the following suggestions:

"It seems to me that two kinds of work need to be carried on, the first and the one of primary importance being the development of facilities for technical training in transportation, granting to the various studies included in the same all the dignity of university teaching and making the transportation school as direct and natural an opening into transportation as the medical and law schools are to medicine and law. The second is the more systematic provision of technical education for the men already in the service, the great majority of whom, for many years to come, must necessarily be without the initial training referred to above. Much may be said in praise of the work accomplished for employes through the railway clubs and the educational branches of the Railroad Y. M. C. A. and in other ways, but more needs to be done, with greater system, and with more pronounced results.

"In connection with this, my proposal is that the railways should directly encourage the extension of transportation teaching at all the large universities.

"One distinctive feature of this college should be the arrangement of the work of its members. The students should follow their classes from the beginning of October until the middle of June, and from that time until the middle of September should be placed on the railroads at a small salary to learn the practical details of the business. They could be used to fill in odd vacancies and, even if they do not accomplish much, they would probably earn the small salary assigned. The combination, in each year of college life, of the theory of the class with the practice of the road would be beneficial both mentally and morally to the student. Any inclination to the 'swelled head,' acquired in the class room, would be knocked out of him most effectually by his associates in employment. During the whole period of the three months, he would be required to submit weekly reports as to the work he was doing, with descriptions of and observations upon the same.

"The courses of the railway college should provide training on five different sides, mechanical engineering, civil engineering, electrical engineering, commercial and operating, all with distinct reference, of course, to railroad work. To effect this, the college should be in close touch with the engineering department of the university, so that courses common to the railroad and general engineering should not need to be handled in the railway college, only those courses coming under its direct charge which bear a distinctly railroad aspect, for instance, railway construction, maintenance of way, locomotive construction, locomotive tests, and so forth.

"The companies would benefit by the leavening influence exerted by the steady influx of able and broad-minded young men, whose training would enable them to see far above and beyond the petty aims and strifes of unregulated unionism, and who would become natural leaders of thought among their associates. Their influence would strengthen good discipline, encourage amiable relations between men and officers, because there would be better understanding of one another's duties and responsibilities. The work of the school would have a direct bearing upon the labor problem as it faces the railroad companies to-day.

"In addition to this work of instruction, the Railway College should become a world-famous center of research work. As its testing plants, appliances and libraries develop, its faculty and advance students, in association with practical railway men, could be constantly devoting attention to the consideration of the improvement of railway facilities in all departments. I should like to see its libraries associated with a bureau of information, which should collect, classify and make readily accessible the results of the investigations of all countries and all investigators on railway subjects."

SCHOOL OF RAILROAD ENGINEERING AND ADMINISTRATION.—The University of Illinois, Urbana, Ill., announces the establishment of a new school of railroad engineering and administration, which will be opened for work in September of this year. This is the first school of this kind to have been established, and it is intended to cover the entire field of railroad service, both engineering and management. In addition to the regular faculty, prominent railroad officials in different departments will deliver special lectures during the course.

Mr. Willard A. Smith, of Chicago, has received from the Emperor of Japan the decoration of the Imperial Order of the Rising Sun, in recognition of his services to Japan while chief of the transportation department of the Louisiana Purchase Exposition.

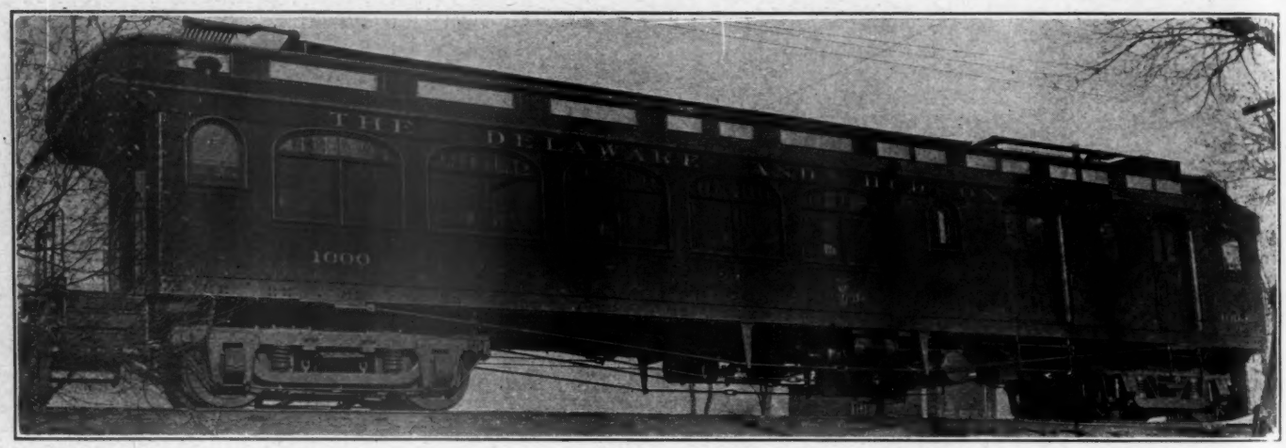
## GASOLINE ELECTRIC MOTOR CAR.

DELAWARE AND HUDSON COMPANY.

That there is an important field of usefulness for an independently driven passenger car is being recognized, is evidenced by the persistency with which the problem of building a special car for this work is being undertaken in different parts of the country. This subject has received longer study and more experiments have been made in England than in this country and there are now a comparatively large number of independently driven motor cars in successful operation on English railroads. A fair proportion of these are steam driven, while others are propelled either by gasoline engine direct or through the medium of an electric generator direct-driven by a gasoline engine and electric motors on the truck.

In this country the latter two systems seem to have been given the greater amount of attention. The most notable example of the former method is the type of motor car used on the Union Pacific Railway, which was illustrated and described in the AMERICAN ENGINEER AND RAILROAD JOURNAL, November, 1905, page 420.

Of the gasoline electric motor cars there have been several different examples constructed and tested, most of them with fairly successful results. This system has many advantages in the matter of easy and efficient control, more rapid acceleration and less difficulties in the operation of the gasoline engine, which can be run at a constant speed instead of being changed as the speed of the car changes, and for those reasons it is being given the greater amount of attention.




GASOLINE ELECTRIC MOTOR CAR—DELAWARE AND HUDSON COMPANY.

One of the latest examples of motor cars of this type was recently built by the General Electric Company and American Locomotive Company for the Delaware and Hudson Company and is illustrated herewith.

This car is over 65 ft. long and weighs about 65 tons. The engine and dynamo are located in a compartment at one end of the car and just behind it is a small baggage compartment. The remainder of the car is taken up by a smoking room and a regular passenger compartment, and there is also a motorman's compartment at the opposite end. It will seat 40 passengers, total, and is built on the lines of the standard Delaware and Hudson passenger coaches.

The gasoline engine used in this car was built by the Wolseley Tool and Motor Car Company, Ltd., Birmingham, England, and is said to be the most powerful gasoline unit ever constructed for this class of work. It develops 160 brake h.p. at a speed of 450 r.p.m. There are six horizontal opposed cylinders, three on each side, each 9 ins. in diameter and 10-in. stroke. The general appearance of this engine is shown in the interior view and cross section given herewith, the latter being taken from *Engineering* (London). It will be seen that the valves are mechanically operated from a cam-shaft, each chamber being fitted with two induction and two exhaust valves. These valves are steel forged of the mushroom type. There are two carburettors, one for each set of three cylinders, which consist of a jet set in the mixing chamber, and are fed by gravity from the float chamber. The valve to this mixing chamber is opened by the suction of the engine and is held closed at all other times. The valve controlling the proportions of fuel and air to the mixing chamber is on top of the carburettor. There are two feed chambers for each carburettor, one for gasoline and one for oil, so that either fuel may be used as desired. The air drawn into the carburettor is taken from the crank chamber, the idea being that in case any gas leaks by the piston rings into this closed chamber it will be removed in this manner. Gasoline is stored in steel tanks beneath the car and the exhaust passes through mufflers in the roof. The circulation water for cooling the cylinders is stored in the engine base and is cooled by radiating pipes located on top of the car. There is also a system of piping by means of which this hot circulating water can be used in heating the car. The lubrication is especially complete, being forced feed for all main bearings and pistons and a drip feed for all other working parts.

There has been much difficulty experienced in starting gasoline engines of this size and a very novel scheme has been introduced in this case for overcoming it. The engine is started by means of ordinary black powder cartridges containing sufficient powder to give the piston a pressure equal to about one-half the ordinary working pressure. These cartridges are inserted in a special block in the cylinder heads and are fired by a mechanism which is operated by the timing gear of the usual electric ignition. The first cartridge is exploded by hand and the others are automatically fired at the proper point. There is an indicator on the engine which shows the exact location of each piston in its cylinder and from this the starter can tell which cartridge to fire first. After the engine is started by cartridges in three of the cylinders it picks up its own charge and continues working on a low tension ignition line. There is a special set of lifters for opening the exhaust valves, so that any compressed air or gas already in the cylinders can be removed before firing the cartridges.

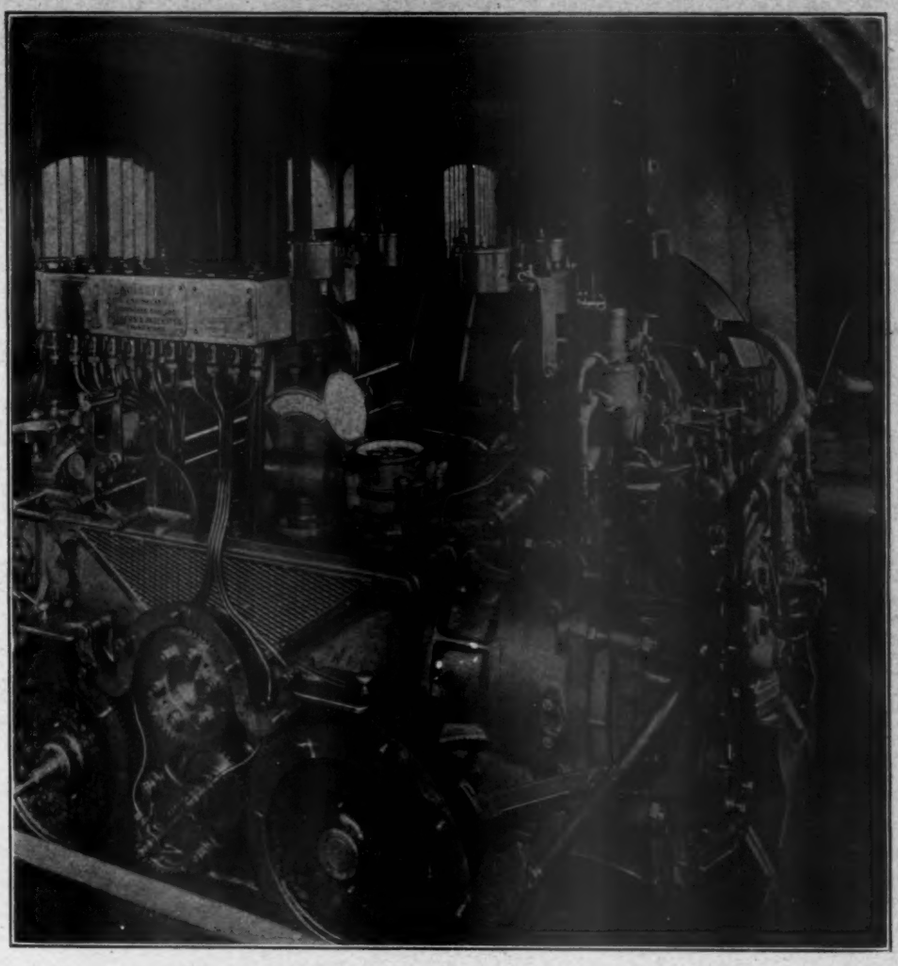
Two ignition systems are provided, a jump spark and a low tension system, the former obtaining its supply from the accumulators and intended primarily for use in case of emergency and the latter obtaining current from a small magneto driven from the engine shaft.

This engine is direct connected to a 120 k.w. General Electric generator, designed for 600 volts. This generator is provided with commutating poles which, in connection with the method of voltage control, permits a very flexible operating system. The special conditions under which this generator operates require a large current at low voltage to give the necessary torque at starting and makes the addition of commutating poles necessary. The generator, while retaining the characteristics of a shunt wound machine, is separately excited by a 5½ k.w. two-pole compound wound exciter working at 110

volts. This is located on top of the generator and is driven by a Morse silent chain. On the trucks there are two GE 69 railway motors, which are similar to those used on the Interborough Railway, New York.

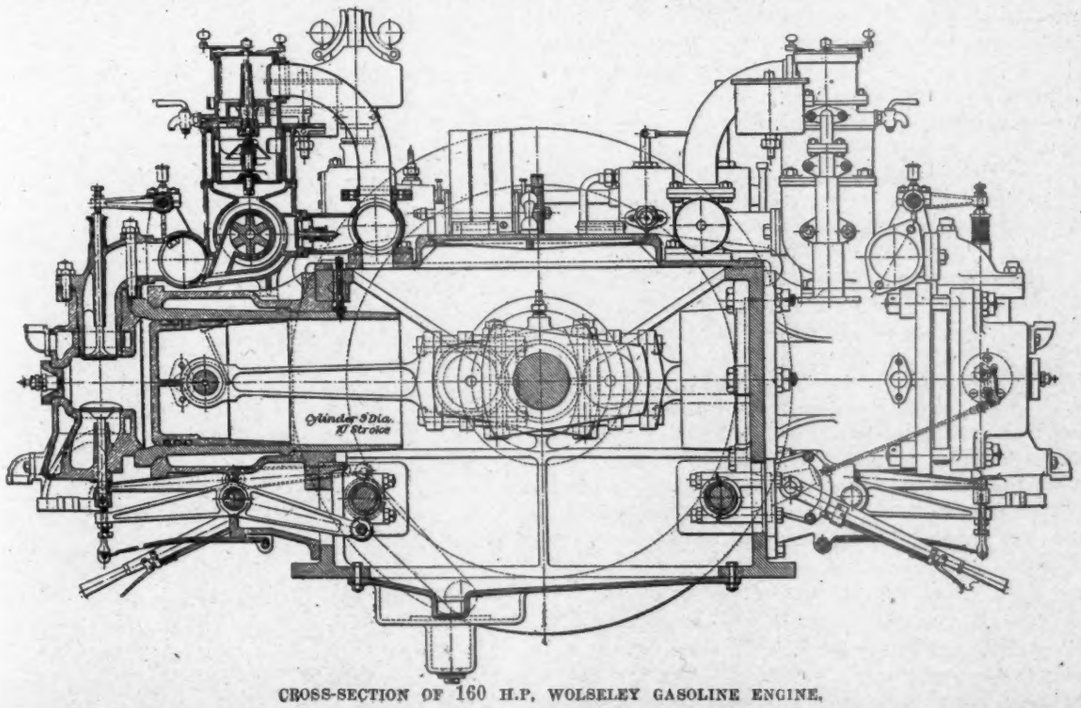
The voltage control speed regulation is used, or, in other words, the speed of the car is governed by varying the field strength of the generator. In this manner the speed of the engine remains constant. The controllers are semi-automatic and can be set for any predetermined maximum acceleration. The series parallel control with five positions of the handle is used.

The first trial run of this car took place on February 3, when a successful trip was made from Schenectady to Saratoga, N. Y., and return. While the car was not designed for especially high speed, the average running time was about 35 miles an hour and at several times it attained a speed of over 40 miles an hour. The running was particularly smooth, no vibration being noted and the acceleration was rapid and smooth.



WOLSELEY GASOLINE ENGINE—DELAWARE & HUDSON MOTOR CAR.

LARGE STEEL-CONCRETE STACK.—The largest and highest concrete chimney in the world has just been completed at the Butte Reduction Works, Butte, Mont. The inside diameter at both the top and bottom is 18 ft. and the height of the chimney is 333 ft. 4 ins. or 352 ft. 7 ins. above the surface. The foundation of the chimney is formed of slag poured in the molten state into a grey iron casing 100 ft. sq. The base is of Portland cement concrete 42½ ft. sq. and 8¼ ft. high. Metal was distributed both through the slag foundation and the concrete base and some of it projected up above the base and into the walls of the chimney. For the first 21 ft. in height the concrete walls of the chimney are 18 ins. thick. Above this the wall is a double shell, the outer one being 9 ins. thick and the inner one 5 ins. thick, with a 4-in. air space between. The concrete walls contain vertical and horizontal steel bars. The weight of the chimney is as follows: Slag foundation, 12,800 tons; concrete base, 1,000 tons; chimney proper, 1,475 tons.




CROSS-SECTION OF 160 H.P. WOLSELEY GASOLINE ENGINE.

## LOCOMOTIVE TESTS AND EXHIBITS OF THE PENNSYLVANIA SYSTEM AT ST. LOUIS.

A 727 page, standard size volume, containing a detailed account of the exhibits, together with the complete results from the locomotive tests made on the testing plant by the Pennsylvania System at the Louisiana Purchase Exposition, has been issued by the Pennsylvania Railroad Company.

This book forms a most valuable addition to locomotive literature, containing, as it does, the first complete and accurate results of the operation of modern locomotives under controllable conditions. Too much praise cannot be given to the railroad system, the exhibition management and the advisory committee for their efforts in this work.

The first chapter deals with the exhibits shown, other than the testing plant. It contains a description of those of the engineering department, which consisted of large models of the West Philadelphia terminal yards, the New York terminal station and the New York-Long Island tunnel; a full size section of the North and East River tunnels and a large assortment of maps, showing recent changes in the line. The exhibit of the voluntary relief and pension departments consisted of charts showing the growth and expansion of this work and copies of reports, regulations and other literature. The charts are reproduced in this book. The Pennsylvania Railroad department Y. M. C. A. exhibits of photographs, tables of membership, etc., is mentioned, and a brief note on the DeGlehn compound locomotive and the typical postal car is also given.

The remainder of the volume is given up to a description of the locomotive testing plant, the locomotives tested and the results obtained. The plant itself is most thoroughly illustrated and described, drawings showing the details of all important parts being included. A similar description of this plant and dynamometer was given in the AMERICAN ENGINEER AND RAILROAD JOURNAL in April, 1905, page 127.

Following the description of the plant several chapters are devoted to the method of forming the advisory committee, its members, the distribution of the operating force on the plant, the plan and scope of the tests and the calibration of the instruments used. This part of the book was issued in its original form as Bulletin No. 1 (AMERICAN ENGINEER AND RAILROAD JOURNAL, January, 1904, page 29).

The next chapter gives the methods of recording tests and considers all the matter given in Bulletin No. 3 (AMERICAN ENGINEER AND RAILROAD JOURNAL, 1904, pages 301, 365, 400), with a number of additions and explanatory notes. The several following chapters give in detail the methods of conducting the tests, the selection of locomotives and why they were selected, installation and preliminary operation of the plant and also an account of the interruptions and delays from various causes.

Then follows a chapter and its appendix for each locomotive tested, which includes a complete report of all observed and computed data, together with tables, computations made for arriving at results, general and detail drawings of the locomotives, typical diagrams at different speeds, typical indicator cards at different speeds and cut-offs and diagrams showing results of counterbalance and vibration tests where such were made.

The last two chapters in the book are given up to comparisons and conclusions, showing both by table and in diagrammatic form the comparisons of all interesting and important features between the different locomotives. These chapters contain the meat of the whole book, and the following extracts from them will give an idea of the valuable information which was shown by these tests and is included in this book.

### BOILER PERFORMANCE.

Results show that when forced to a maximum power the large boilers delivered as much steam per unit area of heating surface as the small ones.

At maximum power the majority of the boilers tested delivered 12 or more lbs. of steam per square foot of heating surface per hour; two delivered more than 14 lbs. and the boiler of the Cole compound engine delivered 16.3 lbs., which is .47 boiler horse power per square foot of heating surface.

The relative advantage of large and small grates is not definitely settled, but the results are conclusive in proving that the furnace losses due to excess air are not greater with the large grate when properly fired than in the case of the small grate. The evaporative efficiency is generally maximum when the power delivered is least.

The results indicate that the percentage of moisture in steam from the locomotive boilers under average conditions is 1½ per cent.

It would appear that there is no special advantage in large firebox heating surface; probably the tube heating surface if ample will absorb the heat not taken up by the firebox.

It would appear that the heating surface of the Serve ribs is not equal to ordinary tube heating surface in capacity.

The temperature of the firebox under low rates of combustion is between 1,400 and 2,000 deg. F., and the maximum values at high rates is between 2,100 and 2,300 deg. F.

The smokebox temperature when worked at light power is not far from 500 deg. F., and has a maximum value when the boiler is forced of between 600 and 700 deg. F.

In general, it appears that the boilers for which the ratio of grate surface to heating surface is largest are those of the greatest capacity.

A brick arch will make possible higher firebox temperature and thus decrease the percentage of CO.

After a relation of .14 sq. ft. of air inlet per square foot of grate was reached no further decrease of draft occurred when the air inlets were increased, and when the air inlets were less than .11 sq. ft. per square foot of grate the draft necessary to supply air increased very rapidly.

In a number of tests the equivalent of evaporation per pound of coal was 12 lbs., and in only a few cases did it drop as low as 6 lbs.

### ENGINE PERFORMANCE.

The indicated horse power of the modern simple freight locomotive tested may be as great as 1,000 or 1,100, and that of the modern compound passenger locomotive may exceed 1,600 h.p.

The maximum indicated horse power per square foot of grate surface lies for freight locomotives between 31.2 and 21.1, and for passenger locomotives between 33.5 and 28.1.

The average minimum steam consumption per I. H. P. for simple freight engines was 23.7; the consumption for maximum power was 23.8, and for conditions which were shown to be the least efficient 29.

The compound locomotives tested using saturated steam consumed from 18.6 to 27 lbs. per I. H. P. hour. The superheater engines gave a minimum consumption of 16.6 lbs. of superheated steam per hour.

In general, the steam consumption of simple locomotives decreased with increase of speed while that of the compound locomotives increased; thus it appears that the relative advantage to be derived from the use of the compound diminishes as the speed is increased. One of the tables shows that there would be no difference between the two at about 200 r.p.m.

Tests under a partially open throttle show that when the degree of throttling is slight the effect is not appreciable; when the throttling is more pronounced the performance is less satisfactory than when carrying the same load with a full throttle and a shorter cut-off.

### PERFORMANCE OF THE LOCOMOTIVE AS A WHOLE.

All of the tests indicate the desirability of using locomotives with ample margin of power for the average work to be done, and no disadvantage is shown in operating locomotives at considerably less than their maximum capacity.

The percentage of the cylinder power which appears as a stress in the drawbar diminishes with increase of speed. At 40 r.p.m. the maximum is 94 and the minimum 77; at 280 r.p.m. the maximum is 87 and the minimum 62.

The loss of power between the cylinder and drawbar is

greatly affected by the character of the lubricant. It appears from the tests that the substitution of grease for oil upon axles and crank pins increases the machine friction from 75 to 100 per cent.

The coal consumption per dynamometer h.p. hour for the simple freight locomotive tested is at low speeds not less than 3.5 lbs. nor more than 4.5 lbs., the value varying with running conditions. At the highest speeds the coal consumption for the simple locomotives increased to more than 5 lbs.

The coal consumption per dynamometer h. p. hour for the compound freight locomotives tested is, for low speeds, between 2.0 and 3.7 lbs. The coal consumption per dynamometer h.p. hour for the four compound passenger locomotives tested varies from 2.2 to more than 5 lbs. per hour. In the case of all of these locomotives the consumption increases rapidly as the speed is increased.

A comparison of the performance of the compound freight locomotives with that of the simple freight locomotives is very favorable to the compounds. For a given amount of power at the drawbar the poorest compound shows a saving in coal over the best simple which will average above 10 per cent., while the best compound shows a saving over the poorest simple which is not far from 40 per cent. It should be remembered, however, that the conditions of the tests, which provide for the continuous operation of the locomotives at constant speed and load throughout the period conveyed by the observations are all favorable to the compound.

It is a fact of more than ordinary significance that a steam locomotive is capable of delivering a horse power at the drawbar upon the consumption of but a trifle more than 2 lbs. of coal per hour. This fact gives the locomotive high rank as a steam power plant.

Copies of this book may be obtained from D. S. Newhall, Purchasing Agent Pennsylvania Railroad Company, Broad St. Station, Philadelphia, at the very reasonable price of $5.00 per copy. This price does not, of course, begin to represent the cost of the book, and is made low so that the valuable information contained may be available to all who desire it.

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THE TRUE FUNCTION OF AN ENGINEER.—"The dollar is the final term in almost every equation which arises in the practice of engineering in any or all of its branches, except qualifiedly as to military and naval engineering, where in some cases cost may be ignored. In other words, the true function of the engineer is, or should be, not only to determine how physical problems may be solved, but also how they may be solved most economically. For example, a railroad may have to be carried over a gorge or valley. Obviously it does not need an engineer to point out that this may be done by filling the chasm with earth, but only a bridge engineer is competent to determine whether it is cheaper to do this or to bridge it, and to design the bridge which will safely and most cheaply serve, the cost of which should be compared with that of an earth fill. Therefore, the engineer is by the nature of his vocation, an economist. His function is not only to design, but also so to design as to ensure the best economical results. He who designs an unsafe structure or an inoperative machine is a bad engineer; he who designs them so that they are safe and operative, but needlessly expensive, is a poor engineer, and, it may be remarked, usually earns poor pay; he who designs good work, which can be executed at fair cost, is a sound and usually a successful engineer; he who does the best work at lowest cost sooner or later stands at the top of his profession, and usually has the reward which this implies."—*Henry R. Towne at Purdue University.*

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WATER SOFTENING.—The benefits to be derived from softening of bad boiler feed waters are now being appreciated by the railroads which have put in such plants. The absence of cracked firebox sheets, reduced flue leakages, shorter detention in the engine house and better steaming qualities are very noticeable on the engines using purified water.

## COST OF LOCOMOTIVE SERVICE AS EFFECTED BY POOLING.

While pooling is known to have a marked effect upon the cost of various items of locomotive service, it has been difficult to secure figures which were strictly comparable illustrating its effect, and this journal has for a long time been seeking for information of this kind. Regretting that the name of the road cannot be given, the accompanying record is presented, having been prepared especially for our use.

The statements cover 20 locomotives in each case. The period of time for the record of locomotives not pooled is from December to March of one year, and the record of locomotives pooled is from December to March, inclusive, of the same locomotives during the following year.

A study of this record, as given in the table below, discloses some very interesting facts in connection with the increased costs of pooling. In comparing the two cases it will be seen that while the total mileage of the 20 engines not pooled decreased 7 per cent., the ton miles total decreased only about 2⅓ per cent., and this was largely in passenger service, the ton miles of freight service being almost the same in both cases. As a total this shows that it would require 44 engines not pooled to handle the same ton mileage as 43 engines pooled, and while the figures given show that by pooling the locomotives the object of more mileage per engine was accomplished to a slight degree, the matter of increased cost of maintenance in all respects increased at a very much larger ratio.

| | Pooled. | Not Pooled. | Decreased. | Per Cent. Decreased |
|---|---|---|---|---|
| Mileage ..... | 2,552,392 | 2,375,235 | 177,157 | 6.95 |
| Ton miles, passenger | 138,167,604 | 125,198,342 | 12,969,262 | 9.4 |
| Ton miles, freight... | 585,501,026 | 581,629,881 | 3,871,145 | .66 |
| Ton miles, total..... | 723,668,630 | 706,828,223 | 16,840,407 | 2.33 |
| Total cost lub. oil... | $5,430.72 | 4,359.59 | 1,071.13 | 19.75 |
| Cost, lubricating oil per 100 E. M..... | $ .213 | .184 | .029 | 13.6 |
| Cost, lubricating oil per 1,000 T. M... | $ .0075 | .0062 | .0013 | 17.4 |
| Total tons of coal.. | 143,978 | 129,138 | 14,840 | 10.3 |
| Lbs. of coal per E. M. | 112.8 | 108.7 | 4.1 | 3.67 |
| Lbs. of coal per 100 T. M..... | 39.79 | 36.54 | 3.25 | 8.15 |
| Cost of repairs, total | $104,266.21 | 87,420.29 | 16,845.92 | 16.1 |
| Cost of repairs per 100 E. M..... | $4.08 | 3.68 | .40 | 9.8 |
| Cost of repairs per 1,000 T. M..... | $ .14 | .12 | .02 | 14.2 |
| Total cost of tools and supplies..... | $4,833.97 | 3,981.00 | 852.97 | 17.7 |
| Cost of tools & supplies per 100 E. M. | $ .19 | $ .17 | $ .02 | 10.5 |
| Cost of tools & supplies per 1,000 T. M..... | $ .0067 | .0056 | .0011 | 16.4 |

The figures for the cost per 100 engine miles and per 1,000 ton miles puts this matter on a fair basis for comparison and it will be seen that the cost of lubricating oil per 1,000 ton miles decreased about 17½ per cent.; the pounds of coal used per 100 ton miles decreased over 8 per cent., the cost of repairs per 1,000 ton miles decreased about 14 per cent, and the cost of tools and supplies over 16 per cent.

These figures are interesting and show clearly that where it is possible to double crew it is most decidedly more economical to do so.

In the table the initials T. M. stand for ton miles and E. M. for engine miles.

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VALUE OF SPECIAL CHUCKS.—On quite a few castings which are to be finished we commonly add a flange or series of lugs to fasten it to a face plate. The metal in these lugs or flanges is paid for at a new metal price and goes back to the foundry at a scrap price, a material loss, of course. Instead of doing this over and over, perhaps a thousand times a year, get your shop inventor to contrive some sort of a permanent chuck which will hold the casting in some other way and will save this waste. A chuck costing $5 will perhaps save $100 a year. —*Mr. C. J. Crowley, Western Railway Club.*

## PENNSYLVANIA TANK CAR PATENTS.

The Official Gazette of the United States Patent Office for February 1st, 1906, contains a notice of the dedication to the public, by the Pennsylvania Railroad Company, of an invention secured by United States Letters Patent No. 790,690, granted May 23, 1905, to William F. Kiesel, Jr., for improvements in the underframes of tank cars. The underframe, embodying these improvements, is of steel, and is strong, light and of simple construction, as may be seen by reference to the accompanying illustrations.

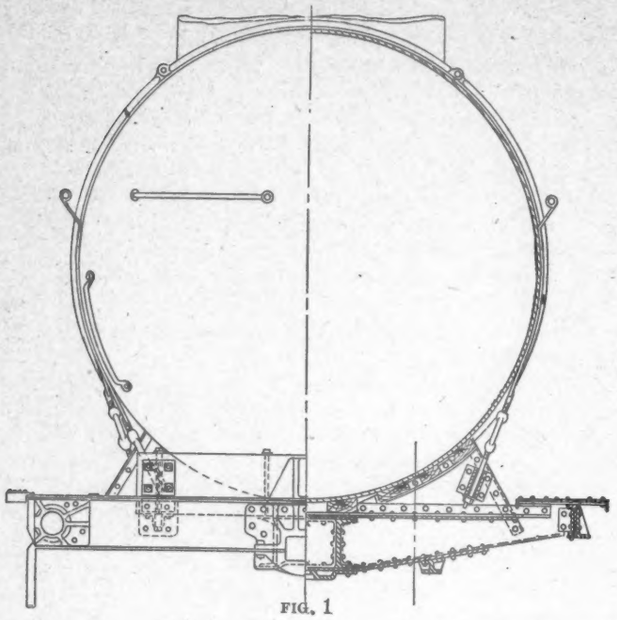


FIG. 1

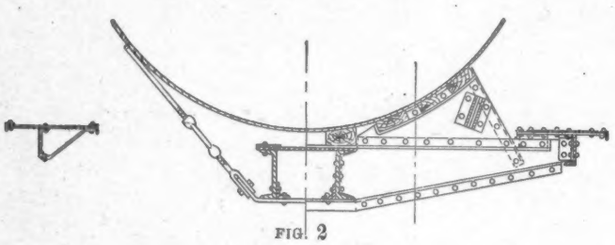


FIG. 2

The center sills consist of heavy channels, which are continuous the full length of the car. These sills have a top cover plate extending between the wooden head blocks against which the ends of the tank rest. Between the body bolsters the sills are reinforced by angles riveted on the inside at the lower edge, as shown in Figs. 2 and 4. The side sills consist of light channels with the flanges turned inward. The function of the side sills is to form spacers and longitudinal braces for the ends of the body bolsters and cross bearers, and also to support the foot boards which extend along either side of the car. The end sills, channels with the flanges turned outward, are secured to the ends of the side and center sills by angle plates.

The body bolsters are formed of two pairs of vertical plates having flanges pressed on the inner, lower and outer edges. Riveted to the flanges at the lower edge is a cover plate which extends underneath the center sills, as shown in Figs. 1 and 7. The flanges on the inner edges of the bolster side plates are riveted to the center sills and those at the outer edges are riveted to the side sills. Extending almost the full width of the car above the centre sills and riveted on the inside of the bolster side plates are angles, to the lower flanges of which is riveted a cover plate. The triangular portions of the bolster side plates, which extend above these angles, are

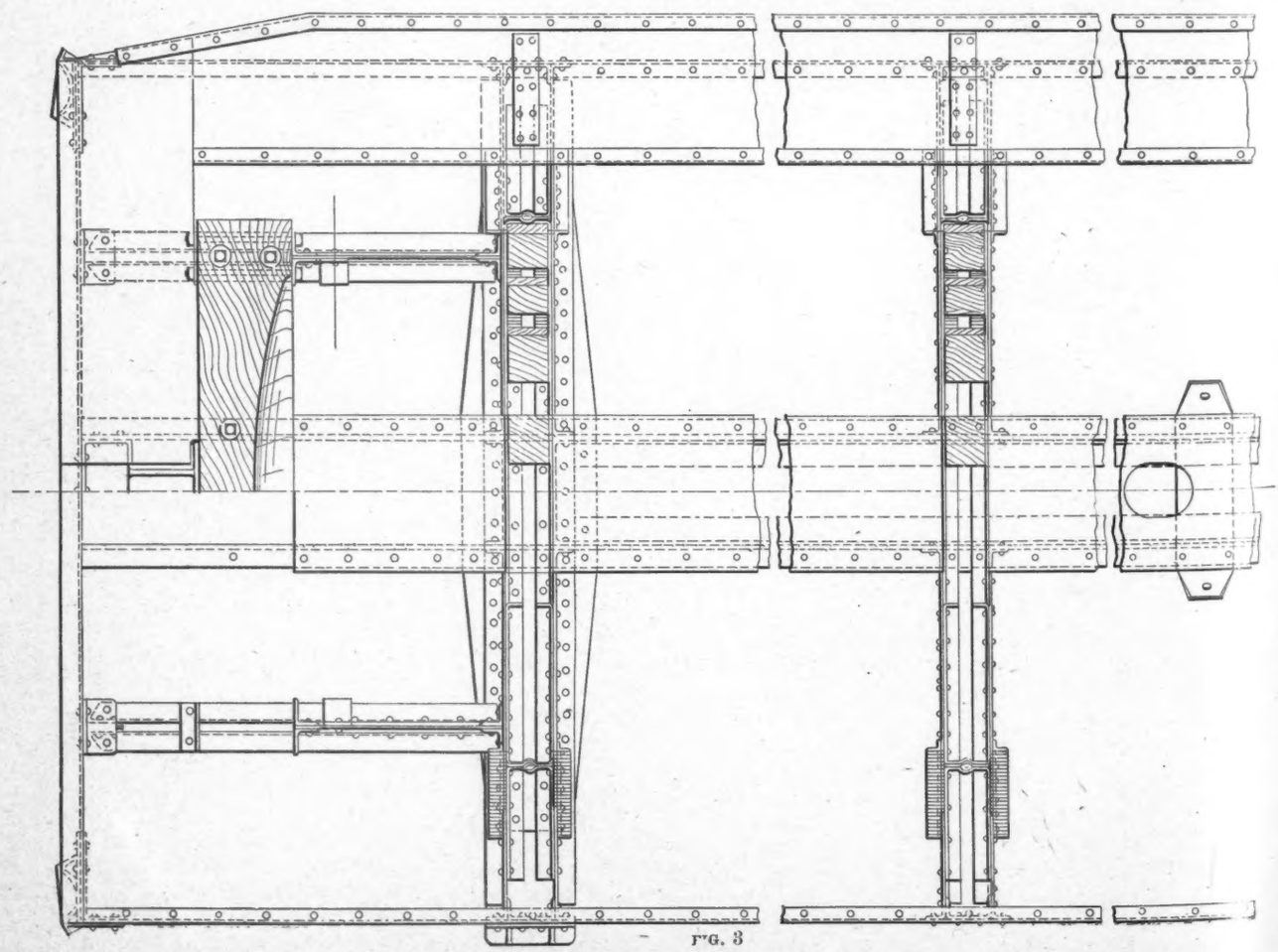


FIG. 3

STEEL UNDERFRAME FOR TANK CARS.

stiffened at the outer edge by light angles, as shown in Fig. 1. The inner or upper edge of these plates is curved to conform to the shape of the tank. On the inside of these curved edges (Figs. 1 and 7) are riveted angles on which are placed hard wood blocks upon which the tank rests. Between the center sills and on a line with the bolster side plates are flanged plates or diaphragms which are riveted both to the webs of the center sill channels and to the top and bottom bolster cover plates. To the bolster side plates and between them near the outer edge of the upper triangular portion, are riveted inclined eye-plates which receive the bolts to which the strap, which passes over the tank, is connected by turnbuckles.

The hard wood head blocks, which are shaped to conform to the end of the tank and prevent it from moving endwise, are bolted to the center sills and also to the angles which extend from the body bolster to the end sill and are riveted to the bottom of the vertical plate or brace, which

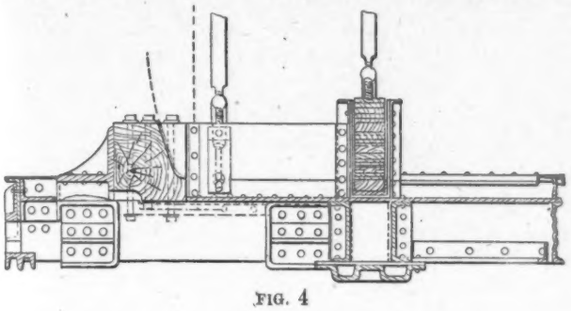


FIG. 4

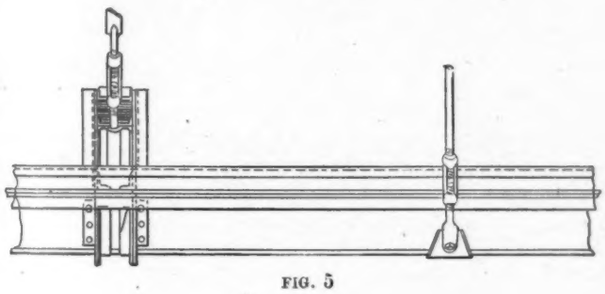


FIG. 5

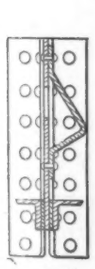


FIG. 6

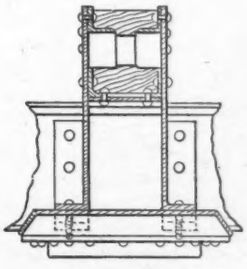


FIG. 7

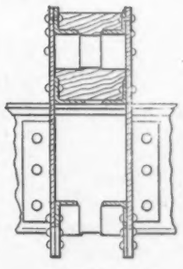


FIG. 8

extends between and is fastened to the body bolster and the head block, as shown in Fig. 4. Secured to a bracket (Fig. 6) on these vertical braces is a strap which passes around the end of the tank and holds it securely in place upon the head blocks. The head block is also braced by the heavy steel end casting which is riveted to the ends of the center sills and projects above them.

The foot plates, which extend along the sides of the car, are riveted to the top of the side sills, and between the bolsters and the cross bearers are supported at the inner edges by braces, as shown in the small figure at the left of Fig. 2. These foot plates are stiffened at the inner and outer edges by light angles.

Spaced equally between the body bolsters are two cross bearers, the construction of which is shown in Figs. 2, 3 and 8. The construction of these cross bearers is quite similar to that of the body bolsters except that the upper and lower cover plates are omitted and the lower edges are not flanged, but have angles riveted to them, which extend underneath the center sills and are riveted to the reinforcing angles on the sills. The diaphragms or flanged plates between the center sills are also omitted.

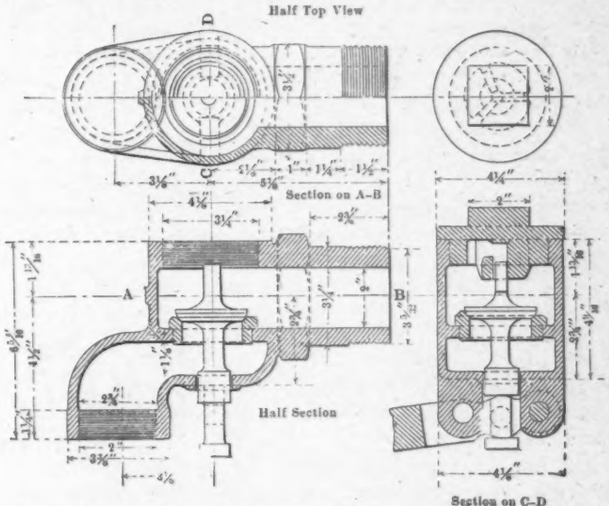
At the center of the underframe is a stirrup plate, shown in Figs. 3 and 5, to the upturned edges of which are attached eye-bolts which connect by turn-buckles with rods connected to a yoke which encircles the dome on the tank, thus preventing it from turning on the frame saddles.

## STANDARD BLOW-OFF COCKS.

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

By placing the regulations for the use of soda ash in the hands of a competent official of the department, this road has found it possible to make a great saving in boiler repairs and greatly improve locomotive service. In connection with this practice, the frequent blowing off of boilers and thorough washing out becomes important.

In the back head 11 washout plugs are provided, in the neighborhood of the throat three plugs, three more on each side at the crown sheet and four in the lower portion of the water legs at each side. In addition to these, the throat sheet




STANDARD BLOW-OFF COCKS—L. S. & M. S. RY.

has three plugs and the front flue sheet two. A surface blow-off is located in the back head, and the standard 2-in. blow-offs are placed in the water legs on each side, 10 or 12 ins. above the mud ring. This height is found desirable in order to save the blow-off valve seat from cutting from staybolt chips or scale. Mud settling below the blow-off cocks is removed through the washout plugs by frequent washing out. The construction of the blow-off cocks is shown in the engraving. They are operated by means of levers connected to handles extending up through the running boards. The drawing has been received from Mr. R. B. Kendig, mechanical engineer of the road.

CARS BUILT IN 1905.—Official returns from all of the car building plants in the United States and Canada, with the exception of one of the smaller builders, whose output we have estimated from our current records, show that 168,006 cars were built during the year 1905, including cars for use on subway and elevated railroads, but exclusive of street and interurban electric cars. These figures do not include cars built by railroads in their own shops, of which an exceptionally large number have been built this year. Of the above total, 165,455 are for freight service, and 2,551 are for passenger service, 162,701 are for domestic use, and 5,305 are for export. This is the largest car output in any one year that we have yet reported, and is considerably more than double the total output for last year, which was 62,950. The next largest output for any one year was in 1902, when a total of 162,547 cars were built.—*Railroad Gazette.*

## IN THE RAILROAD SHOPS.

By A. S. Atkinson.

Shop kinks and devices for saving time, labor and power may be picked up occasionally in visits to the different railroad repair shops, but it is not always possible to adapt them entire to other places. Master mechanics, foremen and others frequently originate methods of saving time and money, which, while they are hardly valuable enough to patent, are worthy of imitation. The distribution of the different mechanical implements of a shop to save space and increase their efficiency is a matter that usually requires the technical training of designing engineers, but not infrequently a shop foreman can make suggestions that come from actual practical work that are of the utmost value. A great deal of the weakness of many designs for shop installation is due to the fact that the practical workers, the foremen, mechanics and operators, are not considered as factors of sufficient importance to consult. In too many cases the designing engineer considers the distribution of the different machines solely from the standpoint of economy of space and the cost of supplying them with power. The grouping of machines on one shaft or pulley so that they can be operated singly or together at a minimum cost of power is a good thing, but when they are arranged so the operators must waste considerable time in getting at the different machines the economy is not always so apparent.

For instance, in one railroad shop where modern machine tools are in use a combined vertical and horizontal spindle milling machine was installed near the center of the shop. This machine was up to date in construction, and represented the acme of modern invention in this direction. It was capable of doing a wide variety of work. Circular pieces could be machined with either the vertical or horizontal spindle. The machine was provided with spindles for face milling cutters, and by means of a detachable table almost any form of cutting could be done. The different cutters could be driven in unison or singly, and also at variable speed. The capacity of the machine was as important as its adaptability. In all respects this complex machine was the triumph of modern ingenuity. But it was a source of concern and irritation to the mechanics and operators. Not one, but half a dozen, swore at it repeatedly, and intimated that they wished the thing was out of the shop. And why? Not because it did not work well, and perform all that the manufacturers had promised, not because it did not work smoothly and accurately, or that the cutting was not satisfactory in every way. But because the designing engineer had sought to economize space in the installation to such an extent that operation was badly handicapped. There may have been an economy of space, and the machine did more work for the space it occupied than any other machine in the shop. But it was always worked at a disadvantage. The men were forced to cramp themselves to reach the different levers and wheels. They were continually compelled to work in positions that tried their nerves and temper. And it was all so unnecessary. It was merely a case of poor judgment on the part of those who located the machine. In this case there was no remedy except its removal. This was done, however, after it was clearly shown that, taking into consideration the loss of time and annoyance caused in operating it so disadvantageously, it would be economy to make the change. Too often in shop work the comfort of the mechanics and workmen is not considered, and yet it is an important factor that counts in the end. A little tabulation of records will show this.

In a railroad shop in the West, where exact records were kept to ascertain the relative efficiency of different machines, it was decided to make the attempt to secure some data concerning the relative efficiency of the operators. Where mechanics of a certain grade are all paid alike it is natural to suppose that their relative efficiency is approximately the same. But it is not. They differ greatly, far more than the machines themselves. One is not only a competent mechanic and good operator of a complicated lathe or cutting machine, but he seems to turn out more work than another with comparative ease. Efficiency is a second-nature to him. To another it is an acquired art, and a difficult one at that. He labors and sweats harder than the first, but he never accomplishes as much work. It is impossible to eliminate this human element from the modern shop, no matter how many improvements are made. But there is another point which careful records of work bring out. Why should a group of workmen of one shop show a higher efficiency, a greater productive output, and a greater amount of high-grade work than a similar group in another shop? The records of the output of the men in charge of drills, lathes, grinders, punching machines and riveting machines in the above mentioned shop showed a variation of 5 to 20 per cent. Some men seemed to outclass all the others, and on certain days their work ran much higher than others. There was no way to account for this other than that some workmen, like some machines, were superior and capable of greater and better grade work. But when the average of the output of the class was compared with the records of another shop where similar data were collected it was found that the latter showed an efficiency nearly 10 per cent. greater than the average of the former. What was the cause? An investigation followed. The men appeared no better, and, in fact, many of them were not as competent. The suggestion was then made that it was the difference in the convenient arrangement of the machinery and the greater comfort of the men in their work. Efforts were made to change this. The foreman sought to improve the ventilation of the shop, shifted some of the smaller machines so fewer steps were necessitated in going from them to the larger machines, and even the lights were changed. The result of this was apparent within a month. The record of output of work steadily increased, and at the end of the year the data collected showed that the difference between the two shops had been wiped out.

One of the greatest improvements made in recent years in railroad shops has been in the matter of lighting. Several of the largest shops have installed perfect electric lighting systems, and a number have adopted the mercury vapor lighting system. This is a distinct gain in the milling department, where nice adjustment of the cutting tools is essential to perfect work. The adjustment of these cutting tools so that there will not be a variation greater than one-hundredth of an inch requires expert skill and time, and where the light is poor much valuable time is lost. In one shop the location of a large engine lathe was such that a distinct shadow was cast upon the place where careful measurement was necessary to set the tools. The practice had been for the mechanic to get an assistant to hold a lighted candle while he made the necessary adjustment. The time of two men in this way wasted did not seem to strike the superintendent or foreman of the shop for some time. Then one of the mechanics grumbled and said he could do 20 per cent. more work if he had a decent light. A drop incandescent light was furnished him suspended on a flexible cord, and he could shove this in any part of the machine he wished to inspect. He proved his assertion a dozen times over that he could save money with a proper light.

Of course, in the drafting room good light is supplied, and a great deal of thought has been expended in order to furnish the draftsmen just the proper kind and degree of light; but too often in the machine and repair shop the light is indifferent. Rapid, skilful workmanship is consequently hampered. Careful record of shop work during a given period will prove this. But it probably needs no proving to-day, for the tendency is to develop perfect lighting systems in all modern shops. The effect of the light upon the minds of the workmen is not an imaginary factor. It can be easily shown that operators turn out more and better work where their surroundings are pleasant and well illuminated. Deep shadows are depressing, especially on dismal, cloudy days. Workmen who find their machines cast in perpetual shadow always give the poorest and slowest returns. Ventilation is likewise of the greatest value. Good ventilation is a matter for the architect

to consider, but in many shops which have been in use for many years makeshifts have been attempted to secure better ventilation. In one old railroad shop the superintendent had directed a carpenter to cut a dozen square holes through the foundation of the building on each side, and to construct boxes similar to those in use for a house furnace. A door controlled from the inside opened and closed the air boxes so that the admission of outside air could be regulated to suit the needs of the men. "That invention saves me several thousand dollars a year," proudly remarked the superintendent, pointing to the home-made ventilation system. "In the first place it gives the men pure air to breathe, and that makes them work better. I guess I get 10 per cent. more work out of them. In the next place, it saves their health. I have fewer men laid off with colds and sickness through the winter. It's a good investment."

The most satisfactory machine ever invented must fail if it is not properly set up and kept in good working order. This is a very trite remark, but it has an important bearing on shop work. Recently, in visiting a shop where several giant engine lathes were in operation, it was suggested that one of the lathes did not work true. "Probably not," was the answer of the foreman, "we've just had the millwrights set it up, and I never saw them do a proper job yet. The machine is set up in a primitive way. If it does not set on a true bed, the men drive wedges under the legs until it is true. They'll manage to get the machine on a level after much work, and then they consider their work done. But how long do you suppose a heavy piece of machinery is going to remain true set up in that way? Those chips will work loose within a week, and then your machine goes into all sorts of wobbly motions. If you are not careful something breaks, and a thousand or two dollars are wasted. You can't expect an engine lathe to bore true when it is not true on its legs. The only thing to do is to make the bed level, and have the machine stand level on its legs without any chips. Our own men generally do that. We have to true up the bed until there is absolutely no variation in the level."

A further examination showed that nearly 90 per cent. of the wooden beds for heavy machines in shops had more or less warp to them, and that chips and other material are used to true up the machines. One foreman said that it couldn't be helped. With an absolutely true floor or bed to begin with there would be a sag to it within a month, owing to the uneven pressure of the head and tail stock carriage. It was therefore necessary to either true up the machine every little while or make constant repairs to the floor. All of which is true, but it can be avoided in shops where it is possible to use concrete beds for the machines. In nearly all of the modern railroad shops concrete beds have been adopted for heavy machines, and this difficulty, which has caused so much trouble in the past, is partly avoided. In one old shop, however, where concrete beds are not used, the machines are trued up by the head mechanic in another way. When there is a sag on one end, the exact size of a chip needed is obtained by measurement. Then a flat piece of forging is made wide enough to cover the legs of the machine. Holes are drilled through, so that when placed in position the screws which hold the legs to the bed pass through the flat chips. In this way the machine cannot work loose, and it will not get out of level again until the wooden bed sags further.

Another method of preventing the uneven working of the heavy machine tools in an old railroad shop was to cut through the floor where the machine stood. A wooden box was then constructed down to the level of the ground, and the inside filled with good concrete, composed of three parts of sand and two of fine Portland cement. This gave a firm foundation to the machine when set up, and made it independent of the rest of the building. When in operation the machines would often cause the old building to shake and vibrate, but when all of the large ones were transferred to such separate, independent concrete beds the noise and vibration were reduced to a minimum. So well did this work that the superintendent declared the ideal way to construct shop foundations was to give a separate, independent floor to each machine. The flooring of the shop elsewhere may then be of brick, wood, stone or iron. The total elimination of vibration makes the machinery work smoother, and gives more certain results. Moreover, the repairing of each separate bed can be carried on more economically. Even for the lighter machinery this method has its advantages.

The crane equipment of any shop is its strongest or weakest point. Where the equipment is so carefully planned that every part of the shop can be reached with equal facility little need be said; but how many shops are thus equipped? In most of them there are nooks and corners that have been overlooked. In installing the overhead cranes it was not thought that any heavy lifting would be required for these neglected places, but in the expansion of the work new machines are installed, and the need of cranes which will reach every part is imperative. The ordinary portable cranes, with a lifting capacity up to 4,000 lbs., are thus necessary. Such cranes are small, compact and easily handled. They can be used in inaccessible corners and under low-ceiling parts of the shop. Home-made cranes of this character have been used in a number of shops for years, and the modern portable cranes really owe their origin to such primitive home-made cranes. Such a structure was built on a low-wheel truck some ten years ago in a railroad shop in the East. A forged L-shaped piece of iron, with a wide flat foot that screwed on the surface of the truck, was used for the lifting part of the crane. A chain running through a wheel on the end of the crane, and over a guide wheel at the break in the inverted L, and thence into a pulley wheel, carried the load. Heavy loads up to a ton and more could be lifted by this crane, and the truck could be pulled or shoved to any part of the building. The crane proved so serviceable that another of heavier carrying and lifting power was built, and to-day these two home-made affairs are in constant use, although factory-made portable cranes have been in the market for a number of years.

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POWER PLANT ECONOMICS.—The following summary is presented in connection with a valuable paper on "Power Plant Economics" presented before the New York meeting of the American Institute of Electrical Engineers by Mr. Henry G. Stott.

1. The present type of steam-power plant can be improved in efficiency about 25 per cent. by the use of more scientific methods in the boiler room, by the use of superheat, and by running the present types of reciprocating engines high pressure, and adding a steam turbine in the exhaust between the engine and the condenser. At the same time the output of the plant can be increased to double its present capacity at a comparatively small cost for turbines and boilers.

2. The steam-turbine plant has an inherent economy 20 per cent. better than the best type of reciprocating engine plant, not so much due to its higher thermal efficiency as to a variety of causes.

3. An internal combustion engine plant in combination with a steam-turbine plant offers the most attractive proposition for efficiency and reliability to-day, with the possibility of producing the kilowatt-hour for less than one-half its present cost.

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LOCOMOTIVE BOILER EXPLOSIONS.—According to *The Locomotive*, the quarterly publication of the Hartford Steam Boiler Inspection and Insurance Company, during the first six months of the year 1905 there were 33 explosions of locomotive boilers in the United States and Mexico. Three of these belonged to private companies and two more were the result of collisions. In the remaining 28 accidents there were 38 persons killed and 40 seriously injured.

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PATTERNS FOR RAILROAD SHOPS.—It is a patent fact that patterns for railroad shop use are not skinned to the limit demanded by manufacturing concerns whose chiefs are generally principal shareholders in all profits.—*Mr. C. J. Crowley, Western Railway Club.*

## SIMPLE CONSOLIDATION LOCOMOTIVE WITH WALSCHAERT VALVE GEAR.

BOSTON & MAINE RAILROAD.

The American Locomotive Company has recently delivered to the Boston & Maine Railroad an order of six consolidation locomotives equipped with Walschaert valve gear, one of which is illustrated herewith.

These engines are very similar to a large order previously supplied to that road which were fitted with the Stephenson link motion, and the two different designs are now being operated in the same service over the Fitchburg division between Boston, Mass., and Rotterdam, N. Y. Although they have not been in service long enough to obtain any comparative figures on operation or cost of repairs, Mr. Henry Bartlett, superintendent of motive power, states that this valve gear has developed a most favorable impression on all concerned, and that it is the general impression that the engines equipped with it will handle in the neighborhood of 50 more tons than similar engines with the Stephenson gear. The present indications are that the roundhouse work promises to be much easier on these engines than on the others. In speaking on the subject, Mr. Bartlett states that he believes there has been no mistake made in applying the Walschaert gear, saying that, "the reduction of weight by the use of the Walschaert gear, the use of the single instead of the double eccentric, the readiness with which the motion work can be inspected and repaired, and last, but not least, the existence of constant lead, are features which readily commend this type of valve gear, and which, I believe, are going to make it so satisfactory that we shall see it applied to almost everything before many years."

A considerable change has been made in the cylinders of these locomotives for the purpose of obtaining a simple arrangement of the Walschaert valve gear in that the valve chamber is placed above with its center 4 inches outside the center of the cylinder. This permits the valve stem to connect direct to the combination lever extending up from the cross head connection. The bracket holding the link is fastened to the guide yoke, which is extended for this purpose. This arrangement gives the simplest and most direct design of Walschaert valve gear which we have seen.

In other respects the locomotive contains no particularly new features, being built on lines which are common to engines of this class and weight constructed by this company.

The general dimensions, ratios and weights are as follows:

2—8—0 TYPE SIMPLE LOCOMOTIVE, WITH WALSCHAERT VALVE GEAR—BOSTON & MAINE RAILROAD.

GENERAL DATA.

| | |
|---|---|
| Gauge | 4 ft. 8½ ins. |
| Service | Freight. |
| Fuel | Bituminous coal. |
| Tractive power | 33,400 lbs. |
| Weight in working order | 170,000 lbs. |
| Weight on drivers | 148,000 lbs. |
| Weight on leading truck | 22,000 lbs. |
| Weight of engine and tender in working order | 277,300 lbs. |
| Wheel base, driving | 17 ft. |
| Wheel base, total | 25 ft. 6 ins. |
| Wheel base, engine and tender | 53 ft. 9⅝ ins. |

RATIOS.

| | |
|---|---|
| Tractive weight ÷ tractive effort | 4.53 |
| Tractive effort x diam. drivers ÷ heating surface | 712 |
| Heating surface ÷ grate area | 61.5 |
| Total weight ÷ tractive effort | 5.1 |

CYLINDERS.

| | |
|---|---|
| Diameter and stroke | 20 by 30 ins. |
| Piston rod, diameter | 3½ ins. |

VALVES.

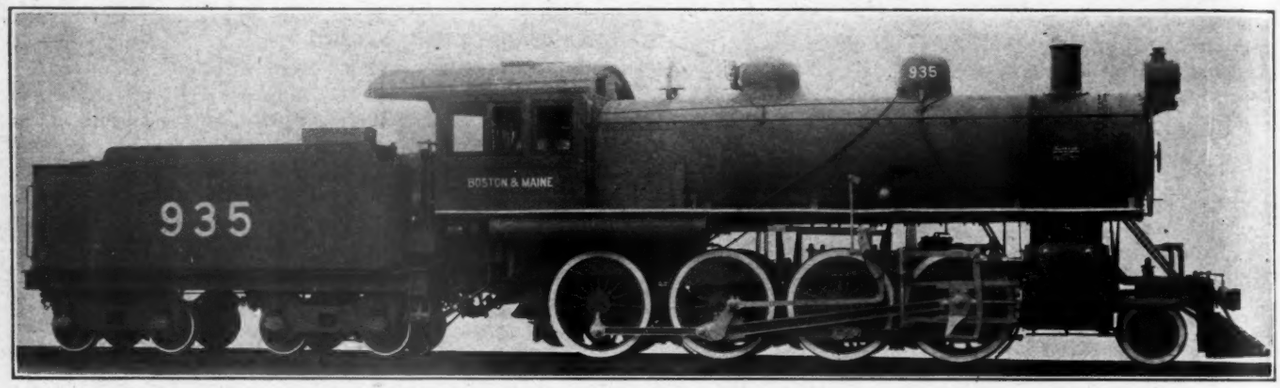
| | |
|---|---|
| Kind | Piston |
| Greatest Travel | 5½ ins. |
| Outside lap | 1 in. |
| Inside clearance | 0 in. |
| Lead in full gear | 3-16 in. |

WHEELS.

| | |
|---|---|
| Driving, diameter over tires | 61 ins. |
| Driving, thickness of tires | 3½ ins. |
| Driving journals, main, diameter and length | 9x11 ins. |
| Engine truck wheels, diameter | 33 ins. |
| Engine truck, journals | 6 by 10 ins. |

BOILER.

| | |
|---|---|
| Working pressure | 200 lbs. |
| Outside diameter of first ring | 66 5-16 ins. |
| Firebox, length and width | 65¼x102⅝ ins. |
| Firebox plates, thickness | ⅜ and ½ in. |
| Firebox, water space | 3½, 4, 4½, 5½ ins. |
| Tubes, number and outside diameter | 326 2 in. |
| Tubes, length | 16 ft. |
| Heating surface, tubes | 2716.87 sq. ft. |
| Heating surface, firebox | 144.2 sq. ft. |
| Heating surface, total | 2861.1 sq. ft. |
| Grate area | 46.5 sq. ft. |




CONSOLIDATION LOCOMOTIVE WITH WALSCHAERT VALVE GEAR—BOSTON & MAINE RAILROAD.

| | |
|---|---|
| Smokestack, diameter | 16 ins. |
| Smokestack, height above rail | 14 ft. 4⅝ ins. |

TENDER.

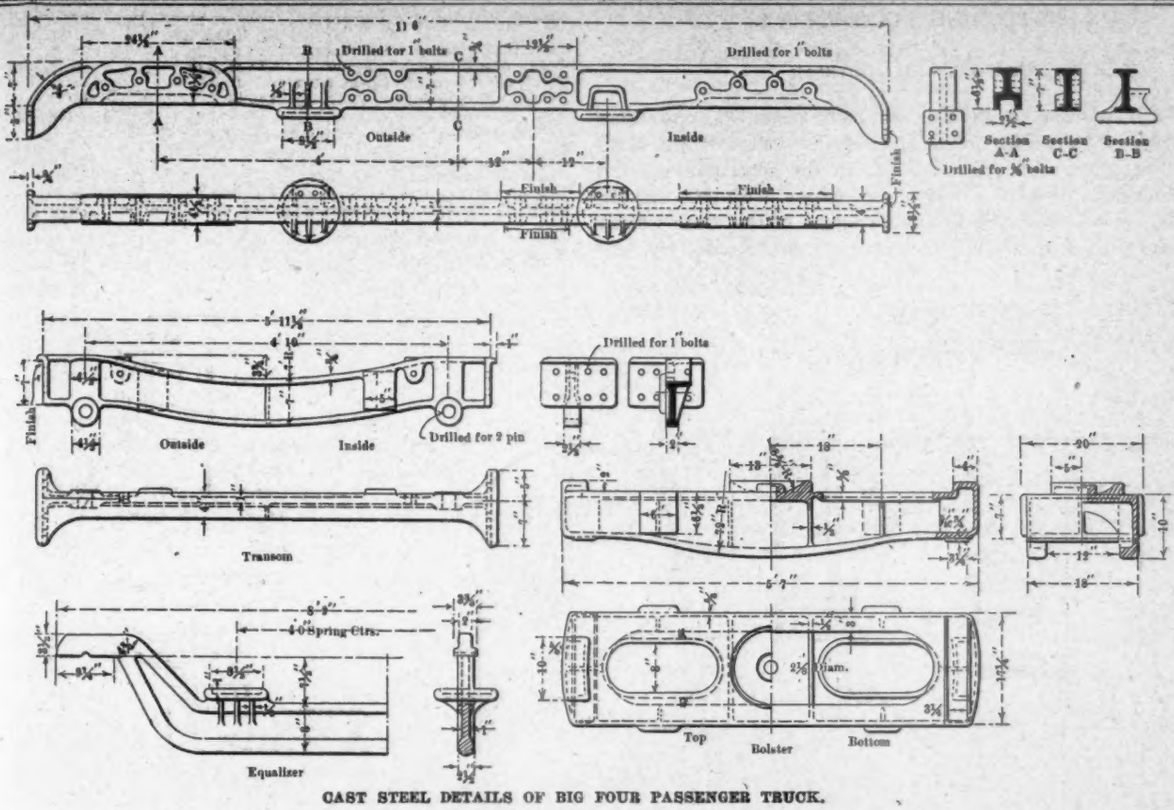
| | |
|---|---|
| Wheels, diameter | 33 ins. |
| Journals, diameter and length | 5 by 9 ins. |
| Water capacity | 5,000 gals. |
| Coal capacity | 10 tons |

## CAST STEEL PASSENGER TRUCK.

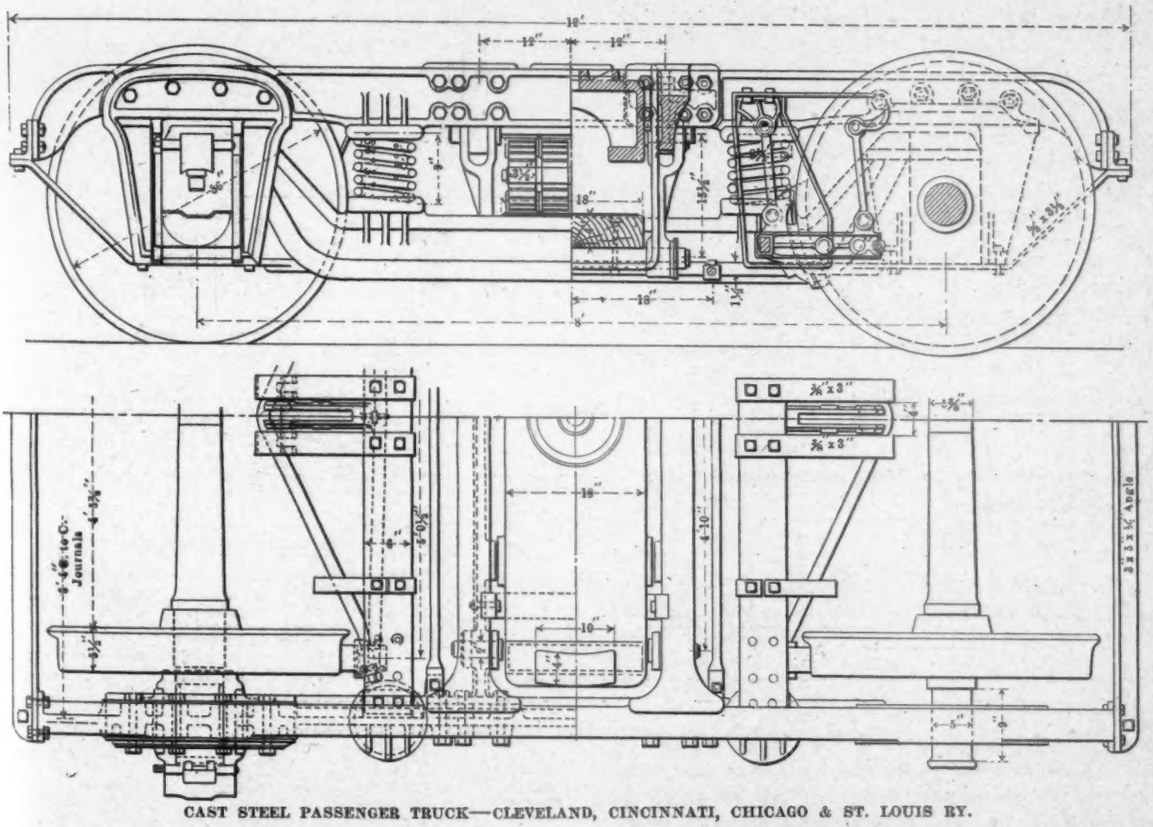
The Big Four has sixteen cast steel passenger trucks in service, four of which have been running about eighteen months, and their performance during that time has been satisfactory in every respect. The truck is designed to take the place of the 6-wheel trucks commonly used under baggage or express cars 60 ft. or more in length. By its adoption it has been possible to save in weight about 9,500 lbs. per car, as compared with the 6-wheel truck, and to reduce the cost about $275 per car. In addition, the friction of two pairs of wheels under each car is done away with, and this affords a considerable advantage in making time with high-speed trains, and is also a source of economy as regards the fuel pile.

With the exception of the wooden spring plank, all of the important members are of cast steel. The general appearance of the truck differs very little from the ordinary type; 5 x 9 in. journals are used and it weighs 13,000 lbs. The center plate and side bearings are cast integral with the bolster, which is of a channel trough section, open at the bottom; is 7 in. deep at the ends, 10 in. deep at the center and is 18 in. wide. The rib along the bottom of the sides is increased from ¾ of an inch thickness at the ends to 1½ in. at the center. The wheel piece is made in one casting 11 ft. 6 in. long, and is of I section between the pedestals; it is 5 in wide, 7 in. deep and the web is 1 in. thick. The equalizer spring caps are cast on the bottom and are strengthened by three ½ in. ribs on the outside and two on the inside.

The transoms are of an inverted L shape, are 7 in. deep and are depressed 3¾ in. at the center. Bosses, 5 x 6 in., cast on the inside act as bolster chafing plates; at the ends a flange




CAST STEEL DETAILS OF BIG FOUR PASSENGER TRUCK.



CAST STEEL PASSENGER TRUCK—CLEVELAND, CINCINNATI, CHICAGO & ST. LOUIS RY.

is formed, 7 in. deep and 12 in. wide, with a lip along the top edge which projects over the wheel piece. This gives an ample bearing for the joint between the transom and the wheel piece, and the projecting lip assists the bolts in taking the downward shear. The equalizer bars are of a dumb-bell section, are 2½ in. wide and 8 in. deep. The equalizer spring seats are cast on them in much the same way as on the wheel piece. The end pieces of the frame are 3 x 5 angles.

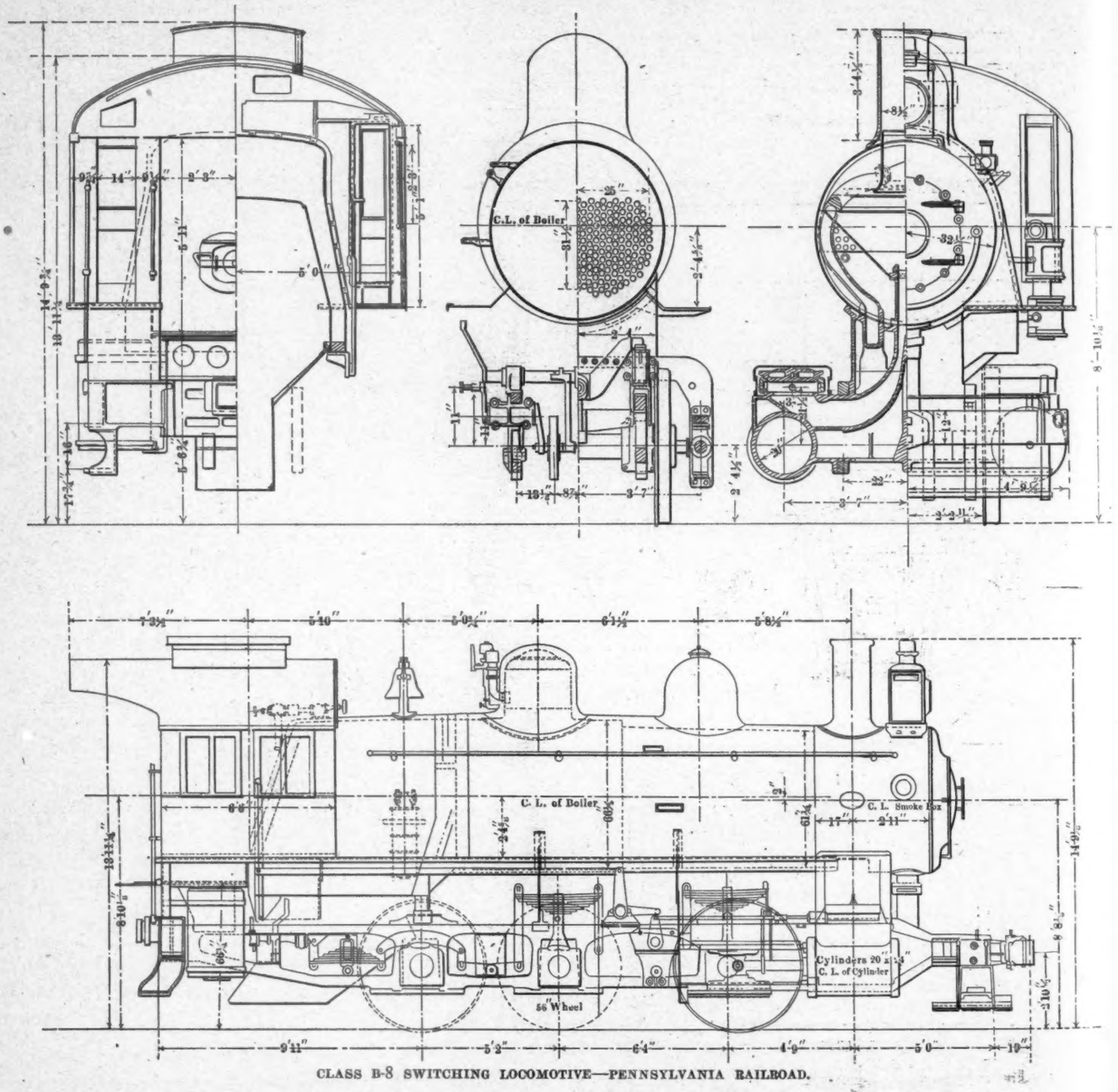
The brakes are inside-hung, and all of the brake rigging is hung from two 6-in. channels, placed with the flanges down. These channels are just outside of the transoms, and are attached at the ends to lugs cast on the inside of the wheel pieces. The wooden spring plank is used to deaden the metallic sound of the truck and to absorb the small vibrations set up in such a rigid construction. Two 1-in. bottom cross ties connect the bottom tie rods and strengthen the truck in a transverse direction. No rivets are used in the construction of the truck, but all of the connections are machined and bolted; this makes it possible to easily and quickly dismantle the truck for repairs. We are indebted to Mr. William Garstang, superintendent of motive power of the Big Four, for information and drawings.

## SWITCHING LOCOMOTIVE.

PENNSYLVANIA RAILROAD.

In this journal in October of 1904, page 384, the Class B—6 heavy switching locomotive of the Pennsylvania Railroad was illustrated. As indicated in the accompanying list of dimensions this is a heavy locomotive with six driving wheels. It was designed to handle trains of the same weight as those hauled by the heaviest road freight locomotives, and

| | | |
|---|---|---|
| Size of driving axle journals | 9½ in.x9 in. D x 12 in. L | 9½ in x9 in. D x 12 in. L |
| Length of driving wheel base | 11 ft. 6 in. | 11 ft. 6 in. |
| Total wheel base of engine | 11 ft. 6 in. | 11 ft. 6 in. |
| Total wheel base of eng. and tendr. | 48 ft. 3¼ in. | 46 ft. 6¼ in. |
| Spread of cylinders | 86 in. | 86 in. |
| Size of cylinders | 22x24 in. | 20x24 in. |
| Steam ports | 10 in. Piston V-2 in. wide | 1¼ in.x15½ in. |
| Exhaust ports | | 2½ in.x15½ in. |
| Travel of valve | 5 in | 5 in. |
| Lap of valve | ¾ in. | ¾ in. |
| Type of boiler | Belpaire, sloping top | Belpaire, sloping top |
| Min internal diam. boiler | 67¼ in. | 60 in. |
| Number of tubes | 325 | 247 |




CLASS B-8 SWITCHING LOCOMOTIVE—PENNSYLVANIA RAILROAD.

was built for use in large yards and in loading car floats.

For general service a new design of the six-wheel type, designated as B—8, has been brought out for service where a large 6-wheel switcher is needed. The accompanying engravings show a side elevation and three sections, and the table shows the leading dimensions of both of the classes referred to. It will be noted that Class B—8 has D valves and a short firebox, but that otherwise the design, except as to heating surface and weight and other features depending upon and affecting them, very closely resembles the earlier Class B—6.

SWITCHING LOCOMOTIVES—PENNSYLVANIA RAILROAD.

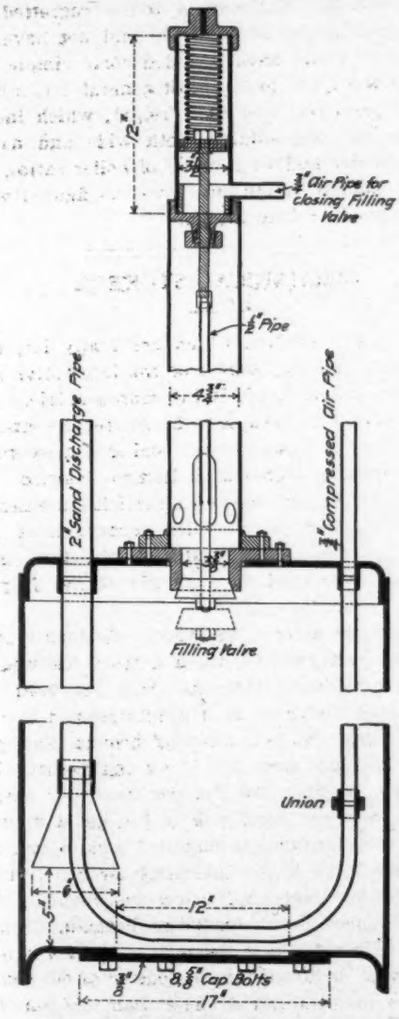
| Class | B—6 | B—8 |
|---|---|---|
| No. of pairs driving wheels | 3 | 3 |
| Diam. of driving wheels | 56 in. | 56 in. |
| Outside diam. of tubes | 2 in. | 2 in. |
| Length of tubes bet. tube sheets | 166¼ in. | 163½ in. |
| Fire area through tubes, sq. ft. | 5.39 | 4.13 |
| Size of firebox (inside) | 66x90 in. | 66x69 in. |
| Fire grate area, sq. ft. | 41.25 | 31.62 |
| Ext. heat'g surface of tubes, sq ft. | 2343.00 | 1762.1 |
| Heating surface of firebox, sq. ft. | 152.10 | 106.1 |
| T'tl heat'g surface of boiler, sq. ft. | 2495.10 | 1868 2 |
| Steam pressure per sq. in., lbs. | 205 | 205 |
| No. of wheels under tender | 8 | 8 |
| Diam. of wheels under tender | 33 in. | 33 in. |
| Size of tender truck axle journals | 5½ in.x10 in. | 5½ in.x10 in. |
| Weight of engine empty, lbs. | 146,000 | 128,900 |
| Weight on first pair drivers, lbs. | 60,000 | 45,900 |
| Weight on second pair drivers, lbs. | 59,500 | 52,600 |
| Weight on third pair drivers, lbs. | 50,500 | 45,600 |
| Wt. of engine in work'g order, lbs. | 170,000 | 144,100 |
| Weight of tender loaded, lbs. | 132,500 | ..... |
| Ratio of heating surface to grate surface | 60.4 | 59.1 |
| Ratio of external flue heating surface to firebox heating surface | 15.4 | 16.6 |

| | | |
|---|---|---|
| Tractive power per lb. of M.E pressure | 207.4 | 171.4 |
| Tractive power with M.E. pressure equal to 4/5 of boiler pressure | 34,020 | 28,114 |

## SAND HOUSE—SOUTHERN RAILWAY.

The Southern Railway has a convenient labor saving sand-house arrangement at Knoxville, Tenn., which has been in use several years. From Mr. J. B. Michael, master mechanic at that point, we have received drawings showing the house and the sand elevating appliances.

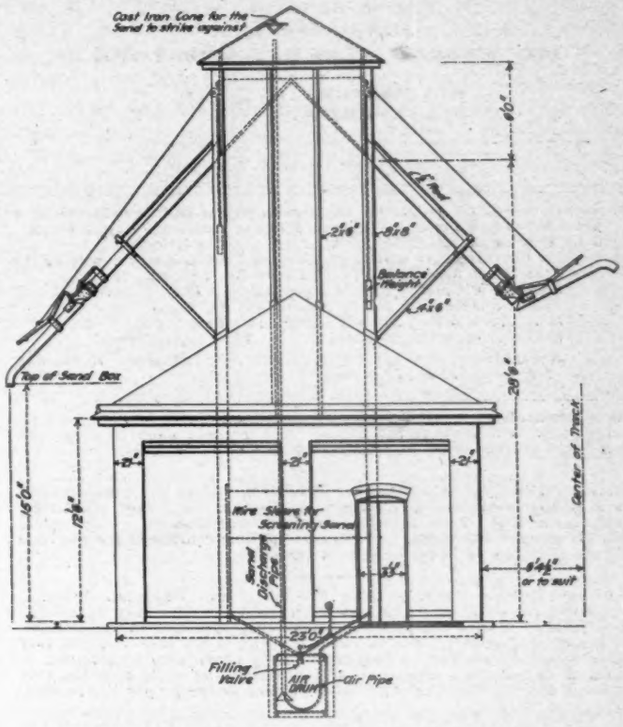
Sand is delivered upon the floor of the sand house and is shoveled upon the heaters. From these the dry sand is thrown upon a screen, through which it falls into a hopper, the top of which is level with the floor, and this hopper discharges into the top of an underground cylinder, which is an old main reservoir from a locomotive. The dry sand flows into this reservoir through the filling valve. When the cylinder is filled, air is admitted through the ¾-in. pipe, which opens under the funnel, and an air jet blows the sand to the top of the storage tower, from which it is discharged into the sand boxes of the locomotives through the spouts. The valve which admits the air pressure to the jet also admits the same pressure to the




SAND ELEVATOR.

cylinder, which closes the filling valve, thus cutting off the escape of sand at the top of the cylinder.

The sand house at Knoxville is 30 ft. 2 ins. by 21 ft. 2 ins., and 13 ft. 6 ins. high at the eaves. It is built of brick, with walls 17 ins. thick, and encloses four sand-drying stoves and a dry sand bin 8 ft. 7½ ins. square, which opens into the cylinder below. The overhead storage bins for dry sand are supported upon 8-in. by 8-in. posts, with a roof over the bins. The roof of the sand house is of slate. The accompanying engravings show the arrangement of the sand house and the manner of its operation. The sand elevator and method of automatically closing the inlet valve at the top of the sand reservoir is similar to that used at the Collinwood roundhouse of the Lake Shore & Michigan Southern Railway. (See AMERICAN ENGINEER, January, 1902, page 9.) Mr. Michael says that the sand cut out the piping very rapidly, and that it was found necessary to replace the delivery pipe with hose, and that the only material found to resist the wearing action of the sand in the valve is rubber.




ARRANGEMENT OF SAND HOUSE—SOUTHERN RAILWAY.

About 60 engines are supplied with sand at this point in 24 hours. One man is employed days and another nights. These men dry the sand, operate the sand plant and supply the engines after they are placed by the "hostlers." By the old method the sand was dried, as now, by stoves, and the dry sand was carried in buckets by two sand-house men and the "hostler," three men in all.

HISTORIC LOCOMOTIVE FOR PURDUE.—The latest addition to the collection of historic locomotives, and the sixth to take its place in the Purdue University Museum, is an 8-wheel connected tank locomotive named "Reuben Wells." This engine was built in 1866 by what was then the Jeffersonville, Madison & Indianapolis Railway for use on an incline which had a grade of 310 ft. to the mile and on which rack locomotives had been used. It was designed by Mr. Reuben Wells, then master mechanic of the railroad, who is now general manager of the Rogers Locomotive Works, for the purpose of supplanting the rack engines on this steep grade. The original engine had five drivers on a side, 20 x 24 in. cylinders and carried the feed water in two long cylindrical tanks below the running boards. The coal space was on an extension of the main frames so that the total weight of coal and water all came on the drivers and gave a weight in working order of 112,000 lbs. The engine operated for a long time in that condition, but was at a comparatively recent date shortened up so that at present it has but four drivers on a side, a smaller coal space, shorter cylindrical tanks and has had a saddle tank added on the boiler.

Labor cost items are generally less than material cost items, therefore it behooves every man in authority in these matters to watch his rough material.—*Mr. C. J. Crowley, Western Railway Club.*

(Established 1832).

AMERICAN ENGINEER AND RAILROAD JOURNAL

PUBLISHED MONTHLY

BY

R. M. VAN ARSDALE.

J. S. BONSALL,
Business Manager.

140 NASSAU STREET, NEW YORK.

R. V. WRIGHT, } Editors.
E. A. AVERILL, }

MARCH, 1906.

**Subscription.**—$2.00 *a year for the United States and Canada;* $2.50 *a year to Foreign Countries embraced in the Universal Postal Union. Remit by Express Money Order, Draft or Post Office Order.*

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**Contributions.**—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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For years it has been our custom to keep on file the names of applicants, or men eligible for various positions. The demand recently has been so great that the list of draftsmen has been entirely depleted and we have been unable to furnish names in reply to twenty or twenty-five requests which have been received during the past month. This is a good indication of the remarkable period of prosperity which the business concerns of this country are enjoying at the present time.

In the rather general movement towards improved educational methods for railroad employees models may be made to play an important part. One of the leading roads has introduced progressive examinations for engineers and firemen, and has fitted up a number of models, by aid of which valve motion, various types of valves and the construction of compound locomotives may be studied. Many locomotive engineers and firemen have run under the guidance of railroad signals, both interlocking and block, for years without knowing more about the signals than that they indicate that trains may proceed or may not proceed. Models of signal apparatus need not be expensive, and they would form a valuable adjunct to educational equipment. If the men who are governed by signals could understand more about the operation of the signals and the reasons and rules governing their use they would doubtless be materially aided in their work. Some of the English roads make a practice of instructing engine men in the use of signals by the aid of models, and the practice has much to recommend it.

There is an interesting problem in engine-house construction for some one to solve. In warm or moderate climates it is relatively easy to know what to do, but where winters are severe, the engine-house question is still unsolved. The apparently necessary factors are proper heating and ventilation, a covered turntable and a house which will not be too expensive. Satisfactory heating in cold weather renders it desirable to avoid the multiplication of doors of the usual roundhouse, and this has led to the construction of rectangular engine houses, with internal transfer tables. A turntable or Y track is necessary with this plan, which, however, seems to be satisfactory as far as the building itself is concerned. At a busy terminal a rectangular house may take up more room than a circular house, because of the necessity for a turntable. A combination of a turntable and a transfer table in the same piece of machinery seems too complicated and too expensive to be acceptable. An engine house with a 100-foot turntable is expensive to build. It is possible that the Echelon engine house, suggested by Mr. J. J. Turner, of the Pennsylvania Lines, may provide a way out of this difficulty.

## THE PENNSYLVANIA LOCOMOTIVE TESTS.

The publication of the results of the locomotive tests made on its testing plant at St. Louis by the Pennsylvania System, the conclusions of which are given in this issue, is an event of more than passing interest and importance. For the first time we have reliable information on the performance of modern locomotives, and have it arranged in such form as to be of practical benefit. While it is to be regretted that the original program of twelve engines could not have been carried out, as that would have included some simple passenger locomotives of the types in the most general use, still a group of eight, four passenger and four freight, which included six different types of compounding, both wide and narrow fireboxes, a superheater and wide limits of boiler ratios, all tested under exactly similar conditions, gives us figures which will be of great value in future design.

## MECHANICAL STOKERS.

Locomotive improvements, which are really improvements, come slowly but the sluggishness of the locomotive stoker, in view of the imperative need, is incomprehensible. In recent years there never has been a want so definite and so well understood as that of means to put coal into a locomotive fire box without requiring tremendous human exertion to accomplish the task. If any one needs an explicit statement on this subject let them refer to the third paragraph of Mr. Garstang's remarks before the Master Mechanics' Association last June, which appeared on page 251 of the July number of this journal as follows:

"Ten years ago the most of us thought the maximum size of locomotives had been reached, when a spurt followed and the locomotive grew rapidly. Has the limit yet been reached? The engine having grown to such proportions in the past ten years, it is pertinent to ask, has the fireman also grown in that time? Experience says "No." An engine with 50 sq. ft. of grate surface, burning 200 lbs. per hour per square foot, will consume 5 tons per hour, and if you get a fireman with sufficient physical endurance to handle 5 tons of coal per hour on an engine scheduled 45 (or 50) miles per hour, as they are to-day, he will very likely fall below the requisite in brain power, and, of course, be an inefficient fireman. This we all know from experience. So it seems our engines have passed the limit of human endurance in the matter of efficient firing."

It would seem that nothing stronger than this can be needed to lead to immediate development of a stoker on a large scale to meet the conditions mentioned. The closing remarks by Mr. Garstang are also worth quoting, as they show his opinion after a wider experience with automatic stokers than any one else has had. His opinion is as follows:

"It is my opinion that the mechanical stoker for locomotives has come to stay, first because it is practical and efficient. Second, we believe by the adoption of the mechanical stoker the railway companies will be enabled to use a cheaper grade of coal than could be used in hand firing, resulting in a great reduction in their fuel bills. It will relieve the firemen of

some of his most arduous labor and give him greater opportunity to observe signals while on duty, and he will arrive at the end of his run in condition to improve his chances by studying for promotion to the position of engineer. The position of fireman on an oil burning locomotive is really attractive, and if the stoker is properly developed his position will be very, very nearly as comfortable with coal as fuel."

## RECORD MAKING.

Record making is, in many respects, a good thing for the railroads. The personal records made by officials called in to do certain things, to accomplish certain results in the way of improvements enables the bookkeepers to show very remarkable results, but this making of records has another side which is, perhaps, not fully appreciated. The sort of record which a railroad needs is that which requires years in the making; it is one which, instead of showing results in one or two specific directions, permeates the whole, and for that reason does not appear on the surface as promptly as the record which is generally most talked about.

Record making on a railroad is somewhat analogous to the manipulation of a large billet of steel in the manufacture of a gun, a shaft, or a rail. Heavy pressure applied superficially will, in a small number of passes, produce a result which is sufficiently attractive in appearance, and is brought out in such a short time as to lead a superficial observer to say that at last we have what we have looked for. One who understands steel, however, knows that the real story of the manufacture will be told after a period of service. He will know that the steel which is worked to the center, as was the old steel rail of years ago, will last in the track and will stand up when a much larger section of rail rolled more rapidly may not give as good service. As the rail sections grow larger, their analogy to the railroad organization is apparent.

As the railroad grows larger, and as the larger railroads are grouped into numerous systems, the character of the problem itself changes and it becomes more and more difficult to reach to the center and make the record which is needed. Perhaps the railroads realize this, and that the proper management of the numerous combinations depends upon the growth of men to correspond with that of the combination, but results recently attained by officials who have been called upon to make records in high places in these combinations indicate that there is a tendency towards the superficial rolling process which cannot possibly reach the center of the masses because of lack of time. Time is required for anything that is worth while, and if anything in the industral field is worth while, it is to organize and operate a vast aggregation of business interests, such as a combination of railroads.

The records which are to be permanent will be those made by men who realize that it takes at least ten years to accomplish anything which is really worth doing. The man does not live who can lead a large railroad which has become slow in matters of progress into the front rank of present-day practice in a year or two. A very large salary may induce some to attempt it, and much may be accomplished by them, but if a man seriously attempts to revolutionize the management of a railroad in a year or two either he will fail for lack of physical strength or the work will be done superficially, with the truth to be revealed later.

The sort of record a railroad needs is that based upon a thorough, comprehensive plan which will bend individuals and methods without breaking them and will draw all interests together in a common effort to produce a truly great result. This result will not stand to the credit of one man. It will not be accomplished in a short time and will probably be conducted as a campaign of a successful war is conducted, with every point covered and provided for. The real record makers are those who will begin at the bottom and build their foundation, and necessarily some time will elapse before the structure itself takes form.

## LARGE ELECTRIC AND STEAM LOCOMOTIVES.

A very valuable paper on this subject was presented at the February meeting of the New York Railroad Club by Mr. J. E. Muhlfeld, general superintendent motive power of the Baltimore and Ohio Railroad. Three important phases of the subject were considered, *i.e.*, it contained a report of the comparative performance for one year of large steam and electric locomotives under fairly similar conditions; also a statement of the essential requirements of the electric locomotive and its source of power, as suggested by the practical experience of the B. & O., to produce the proper efficiency and economy in operation for either passenger, freight or helper service; also a report on the service and results of the large Mallet compound locomotive. The locomotives compared were the two electric multiple unit locomotives, described on page 324 of our September, 1903, issue, which are specially designed freight train helping locomotives, and the large Mallet compound, which was described on the following pages of this journal: 167, May, 1904; 237, June, 1904; 262, July, 1904; 297, August, 1904; 249, July, 1905, and the performance of which was described on page 229, June, 1905. This engine was placed in service January 6, 1905. The following extracts are taken from Mr. Muhlfeld's paper.

### COMPARATIVE PERFORMANCE.

Concerning the performance of the electric locomotives Mr. Muhlfeld said: Considering $1.25 per net ton as a base cost for fuel delivered at the power plant, the average total operating and maintenance expenses during the year for generating the current; the labor and material for the locomotive electrical and mechanical repairs; the engineer's wages; wiping, hostlering, inspecting, oiling and dispatching; lubricating and miscellaneous supplies, was approximately $34.50 per 100 miles run per locomotive. Of this amount the average cost of labor and material applied to each locomotive for the running and shop repairs, would be $3.20 or 52 per cent. for the electrical, and $2.90 or 48 per cent. for the mechanical, making a total average cost of $6.10 per 100 miles run for both the electrical and mechanical repairs.

The above figures do not take into consideration interest, depreciation, taxes nor insurance on the investment, nor do they include the expenses incident to the maintenance of such equipment as battery, feeders, third rail, bonding wires, insulation, safety cut-out switches, extra motors, etc., which is not required for steam locomotive operation. The wages for the conductor, or second man on the locomotive, have also been omitted.

For the Mallet compound the average total operating and maintenance expenses during the year for fuel, water, labor and material for the locomotive repairs, engineer's and fireman's wages, wiping, hostlering, washing boiler, inspecting and dispatching, lubricating and miscellaneous supplies, was approximately $24.50 per 100 miles run. To this figure can be added an allowance on account of general repairs and renewals to locomotive, mileage credited but not actually run, difference in cost of fuel delivered at power plant and on locomotive tender, and for the maintenance of fuel and water supply plants, and there will still be a large margin in favor of the steam as compared with electric locomotive performance, under fairly similar conditions.

### ESSENTIAL REQUIREMENTS OF ELECTRIC LOCOMOTIVES.

From experience, to the present date, it would appear that an electric locomotive and its source of power, to produce the proper efficiency and economy in operation for either passenger, freight or helper service, should fulfill the following essential requirements:

A fire and collision resisting locomotive construction within the present clearance and weight limits; simple in design; reasonable in first cost; safe, reliable and economical for operation at varying speeds and power; and accessible for inspection, lubrication, cleaning, repairs and for replacement on track in event of derailment of any or all wheels, by the ordinary steam locomotive and car methods, without the necessity for the use of a power crane.

A locomotive that can be interchanged and operated over home and foreign tracks, which are suitable for steam locomotive or motor car equipment.

A locomotive composed of two or more interchangeable sections, each a duplicate of the other, and equipped so that each section may be operated from either end, and independently or jointly, with any number of coupled sections; the operation under any arrangement to be controlled from a single section by one engineer.

The elimination of pilot wheels and the concentration of the entire weight on the driver wheels, with a minimum weight per wheel at the rail of 25,000 lbs.; and an arrangement of driver wheels providing for a short rigid and a long flexible wheel base, without excessive end play at axle bearings.

The elimination of armatures from locomotive driver wheel axles and the transmission of power to driver wheels not less than 60-in. initial diameter without the use of gearing, in a manner that will insure the economical use of current at the motors for starting and running, and eliminate the accumulation of unbalanced pressure at the wheel and rail contacts, as well as the independent revolution of one or more pairs of driver wheels when coupled in series, which occurs as the driver wheels become slightly different in diameter due to ordinary wear or material, when making transition in current at motors, or when operating on slippery track or over rails, frogs and switches of varying wear, surface, alignment and elevation.

The least weight between the track and the locomotive frame carrying springs, to minimize the pressures, lateral thrusts and wear at the rail and wheel flanges.

A high center of gravity so that the vibration of the locomotive, due to the variation in surface, alignment, elevation and curvature of track can be absorbed by the weight suspended over the driver springs.

A proper proportion between the electrical, mechanical and dead equipment weights of the locomotive.

Locomotive motors compact, ventilated, cooled, protected from internal damage and mechanical injury, and of ample range of adjustment and capacity to permit of continuous operation at varying or full speed or power without excessive heating of armatures, commutators or fields above the temperature of the surrounding atmosphere. A thin, tough and elastic insulation material, unaffected by humidity or a temperature of 400° Fahrenheit, and having the requisite dielectric strength.

A development of the maximum locomotive power for rapid acceleration and regular working, requiring no transition, as from series to multiple, in the transmission of the current to the motors, and providing for a uniform increase or decrease in tractive power to prevent irregular drawbar stresses.

Suitable pumps to provide compressed air for the locomotive power brake, track sander, bell and signal operation, together with steam train heating device, and the other usual equipment.

Automatic positive devices on the locomotive to insure protection in event of accidental short circuit, or disablement of the engineer.

An arrangement on the locomotive which will automatically provide for electrical braking and return to the line for the use of pulling locomotives, a considerable percentage of the energy that is generated by trains descending grades, or stopping, and which energy is ordinarily wasted in destroying material and equipment by brake shoe action on wheels or rails.

A high potential current producing, and an aerial conveying system, reasonable in first cost and economical for maintenance; the generation of the electrical energy at a central plant for the least cost per kilowatt hour; the transmission of the lowest current over the minimum amount of metal contained in overhead contact lines, protected for weather, voltage and lightning conditions, and insuring continuous operation in event of line or equipment failure or accident; the conservative use of battery as storage for extra power that can be generated at small cost during light load and utilized to good advantage during intermittent and peak loads; the least number of transformer or convertor stations; the minimum feeder, conversion and resistance losses in current, and the elimination of electrolytic action.

### ADVANTAGES OF THE MALLET COMPOUND.

The following are some of the results that can be obtained from this compound cylinder articulated type of freight locomotive, which cannot be duplicated by other single units of steam, electric or internal combustion locomotives now in use on American railroads:

A tractive power of about 84,000 lbs. for starting heavy trains and for a speed of 5 miles per hour; and of 74,000 lbs. at a speed of 10 miles per hour, placed under the control of one engineer and one fireman.

A self-contained machine generating the power necessary to develop its hauling capacity. With electric locomotives, where the source of power is separate from the machine which develops the hauling capacity, the first cost of the locomotive alone is, at present, about 50 per cent. greater per pound of tractive power developed under working load than for steam locomotives of the 2400 type. To this must be added the greater cost for repairs and operation per mile run for the electric locomotive, and the installation, maintenance and operation of a current producing, conveying, storage, converting and distributing system, which would not be required by either a steam or internal combustion locomotive, and all of which increase the capital and operating expenses very materially.

A total locomotive weight utilized for the development of tractive power in connection with a running gear, which makes the locomotive suitable for either hauling, pushing or braking freight trains containing the maximum paying load per foot of track space, over level or mountainous railroads of maximum curvature.

A maximum tractive power with a minimum rail pressure per driver wheel, on account of the total weight of 334,500 lbs. being distributed over 12 drivers, and a 30 ft. 6-in. total, with a 10-ft. rigid wheel base, resulting in minimum wear and tear on bridges, rails, ties and roadway. With electrical locomotives the excessive weight concentrated on a short rigid driver wheel base and below the springs, together with the extremely low center of gravity, results in extraordinary rail pressures, thrusts and wear.

The elimination of retarded movement and stalling of trains, on account of the usual slipping of driver wheels, as in the case of ordinary simple or compound cylinder steam locomotives, or with electric locomotives where the driver wheels are uncoupled and the current is naturally transmitted to the point of least resistance, which is the slipping wheels, resulting in no increase of power at the dead wheels. A higher tractive power is obtained to the weight per axle than with the ordinary steam locomotive, as the slipping due to the accumulation of high unbalanced pressure at the points of wheel and rail contact, does not occur at the same time in both engines. When one engine commences to slip a reduction in mean effective pressure follows, and it regains its grip on the rail without making it necessary to shut off or throttle the steam supply. The other engine, meantime, has been gaining power, thus preventing any appreciable loss of speed and consequent stalling of the train at a critical moment. These conditions are the same whether the slipping occurs with either the high or the low pressure engine, and the most frequent cause for stalling with electric or simple cylinder locomotive is thus overcome.

A tonnage and speed per train that will provide for the least number of locomotives and crews under the control of which the movement of the business is placed. This will result in the balancing of the power and movement of the maximum number of loaded and empty cars per hour over a single piece of track, with the proper degree of safety.

A minimum capital, repair, fuel, engine and train crew, oil, supply and dispatchment cost per locomotive, train, car or ton mile.

A maximum retarding effect for the safe handling of heavy

STRANG GASOLINE ELECTRIC MOTOR CAR.

trains down steep grades at the highest speed permissible for a proper degree of safety.

A uniform turning movement to overcome journal friction of axles; rolling and flange friction of wheels; wave resistance of rail; atmospheric friction at ends and sides of rolling stock and inertia of train at time of starting, which will insure the minimum draft gear, machinery and boiler stresses, and reduce the tire and rail wear.

A subdivision of power and balancing, resulting in the minimum strains on the locomotive and track, and a reduced liability for wear, breakage or accident. Broken driver wheel axles on electric locomotives indicate that the more uniform torque does not eliminate the liability for such failures under normal conditions.

The minimum amount of dead weight and non-paying load, and the smallest number of bearings and parts per unit of power developed.

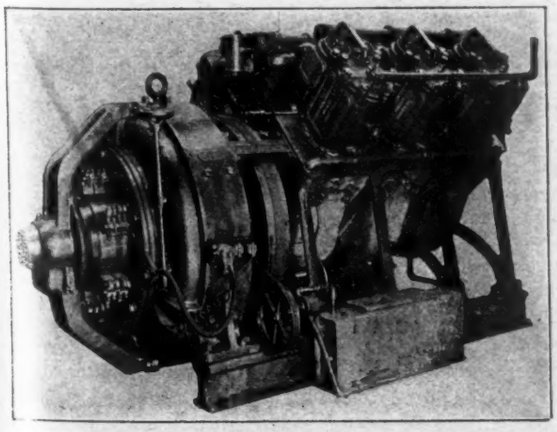
Ability to move itself and train of one-half rating in the event one set of its machinery or engines becomes disabled.

## GASOLINE ELECTRIC MOTOR CAR.

### Strang System.

The J. G. Brill Company has recently finished a gasoline electric motor car for the Strang Electric Railway Car Company, which is to be used to demonstrate the Strang System for cars of this type.

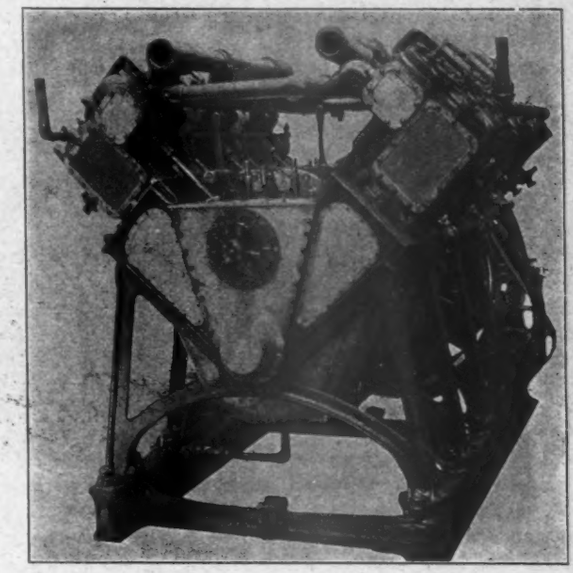
This car, which is illustrated herewith, is at present making a trip from New York to San Francisco for the purpose of exhibition and demonstration. For this reason it is of small



ENGINE AND GENERATOR, STRANG MOTOR CAR.

size and carrying capacity. The same company are now building several larger sized cars for practical use, using the same motive power, for the Missouri and Kansas Interurban Railway.

In brief, the Strang system employs an electric generator driven by a special design of six-cylinder gasoline engine, a storage battery, connected in parallel with the generator, and



END VIEW OF ENGINE, STRANG MOTOR CAR.

an ordinary series parallel control of standard railway motors on the trucks.

The engine, two views of which are shown herewith, is of the four cycle type and has six 8 by 10 in. cylinders. These cylinders are partially opposed, three on each side, and are set at an angle of 90° to each other. Care has been taken throughout the design to make every part as light as is consistent with the requisite strength and for this purpose all casings and parts which are not subjected to strain are made of aluminum and the other parts of cast steel as far as possible.

The vaporizer is arranged to work with either gasoline, kerosene, alcohol or crude oil, as may be desired. The ignition is of the high tension type and has one coil of special design for each cylinder, all being operated from one interrupter. The lubrication of all bearings is ample, as the oil is pumped from a reservoir beside the engine over the bearings to a filter above the reservoir, thus using it over and over again. The cylinders are water cooled, the circulation being by a centrifugal pump, which draws the water from a tank located in a vestibule at the center of the car and forces it through cylinder jackets and to radiating pipes on the roof. In cold weather the passenger compartment is heated by this jacket water. The

heating system is so arranged that hot water is only in enough pipes to heat to the desired temperature.

The engine is direct connected to a 50 k.w. 250 volt direct current generator and on the trucks there are two 50 h.p. series wound motors of regular street railway type. The storage battery, which is placed in a cradle underneath the center of the car, consists of 112 cells having 200 ampere hours capacity. The pressure of 250 volts is used in place of the usual 500 in order to reduce the number of storage battery cells, each of which require about 2½ volts for charging and will discharge at a pressure of about 2 volts.

The storage battery, as above stated, is connected in parallel with the generator and the advantage of the whole system lies in the fact that an engine and generator are required which are of a size only large enough to take care of the normal operation of the car and the battery will help out at periods where extra power is required, such as at periods of acceleration and in ascending grades. The battery also takes care of the surplus current from the generator when the car is standing or descending a grade. Provision is made to prevent the batteries from becoming over-charged by an automatic governing device upon the engine, which depends entirely upon the condition of the batteries for its operation. Current from the batteries is used in starting the engine by using the generator as a motor.

The interior of the car is fitted out with easy chairs and attractive decorations. A controller is placed upon the rear platform as well as at the front of the car. The maximum speed is stated to be 50 miles per hour and the average gasoline consumption is .45 gallons per mile.

It weighs 39 tons total and is mounted on Brill No. 27 type E high speed trucks having rolled steel wheels.

## STANDARD PACIFIC TYPE LOCOMOTIVE.

HARRIMAN LINES.

The Baldwin Locomotive Works are building 28 Pacific type locomotives for the Harriman Associated Lines, one of which is illustrated herewith.

These engines are constructed from the standard designs which were adopted by the associated lines last year, and which were completely illustrated and described in the AMERICAN ENGINEER AND RAILROAD JOURNAL, 1905, pages 154, 200, 250, 288, 322, 353, 400 and 441.

The standard designs were very carefully worked up in all details, and permit a very wide interchange of parts on different locomotives. In this connection it is of interest to note the parts on this Pacific type engine which are common to other types of locomotives on the associated lines which include the Union Pacific, Southern Pacific, Oregon Short Line, Chicago & Alton, Oregon Railroad & Navigation Company and the Kansas City Southern. The following are some of the more important parts common to the standard Atlantic, Pacific, consolidation and switch engines, with exceptions as noted: Eccentrics; cross heads, piston valves, except switch engines; driving boxes, except main, which is common to consolidation and Pacific type; truck wheels, except consolidation; smokebox arrangements; exhaust nozzle; petticoat pipe; general design of cab; grates; grate castings; boiler diameter, except consolidation; size of firebox, except switcher; four-wheel engine truck; truck axles; general design of frame and cylinders; general design of wheel centers and also boiler and engine fittings as far as possible.

The general dimensions, weights and ratios of this Pacific type locomotive are as follows:

4—6—2 TYPE PASSENGER LOCOMOTIVE—OREGON SHORT LINE RAILROAD.

GENERAL DATA.

| | |
|---|---|
| Gauge | 4 ft. 8½ ins. |
| Service | Passenger. |
| Fuel | Bituminous coal. |
| Tractive power | 29,920 lbs. |
| Weight in working order | 222,000 lbs. |
| Weight on drivers | 141,000 lbs. |
| Weight on leading truck | 37,000 lbs. |
| Weight of engine and tender in working order | 384,000 lbs. |
| Wheel base, driving | 13 ft. 4 ins. |
| Wheel base, total | 33 ft. 4 ins. |
| Wheel base, engine and tender | 63 ft. 10½ ins. |

RATIOS.

| | |
|---|---|
| Tractive weight ÷ tractive effort | 4.7 |
| Tractive effort x diam. drivers ÷ heating surface | 754. |
| Heating surface ÷ grate area | 61. |
| Total weight ÷ tractive effort | 7.4 |

CYLINDERS.

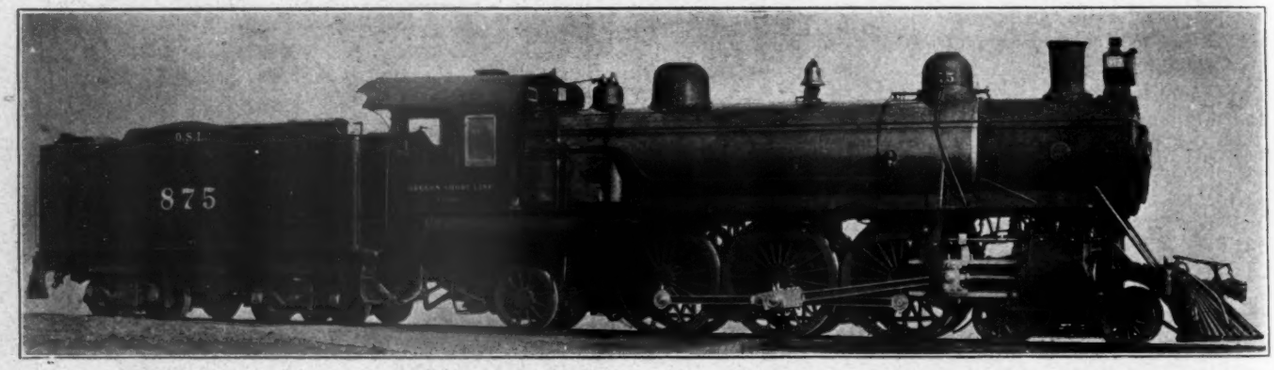
| | |
|---|---|
| Diameter and stroke | 22 by 28 ins. |
| Piston rod, diameter | 4 ins. |

VALVES.

| | |
|---|---|
| Kind | Piston. |
| Greatest travel | 6 ins. |

WHEELS.

| | |
|---|---|
| Driving, diameter over tires | 77 ins. |
| Driving, thickness of tires | 3½ ins. |
| Driving journals, main, diameter and length | 10 by 12 ins. |




STANDARD PACIFIC TYPE LOCOMOTIVE—OREGON SHORT LINE.

| | |
|---|---|
| Engine truck wheels, diameter | 33½ ins. |
| Engine truck, journals | 6 by 10 ins. |
| Trailing truck wheels, diameter | 45 ins. |
| Trailing truck, journals | 8 by 12 ins. |

BOILER.

| | |
|---|---|
| Style | Straight. |
| Working pressure | 200 lbs. |
| Outside diameter of first ring | 70 ins. |
| Firebox, length and width | 66 by 108 ins. |
| Firebox plates, thickness | ⅜ and ½ in. |
| Firebox, water space | 5 ins. |
| Tubes, number and outside diameter | 245 2¼ ins. |
| Tubes, length | 20 ft. |
| Heating surface, tubes | 2,874 sq. ft. |
| Heating surface, firebox | 174 sq. ft. |
| Heating surface, total | 3,048 sq. ft. |
| Grate area | 49.5 sq. ft. |

TENDER.

| | |
|---|---|
| Wheels, diameter | 33½ ins. |
| Journals, diameter and length | 5½ by 10 ins. |
| Water capacity | 9,000 gals. |
| Coal capacity | 10 tons. |

LOW STEAM CONSUMPTION OF CORLISS COMPOUND ENGINE.—A recent test on one of the 7,500 h.p. twin vertical horizontal Reynolds' Corliss engines, of which nine have been in operation at the 59th Street Power Station of the Interborough Rapid Transit Company, New York, since 1902, showed a steam consumption of 11.96 lbs. per indicated h.p. hour. The engine developed 7,365.3 h.p. at 75 r.p.m. and 175 lbs. steam pressure with 25.52-in. vacuum in the condenser. These engines were built by Allis-Chalmers Company under a guarantee that they would not require more than 12.25 lbs. of dry steam per i.h.p. hour when indicating 7,500 h.p. at 75 r.p.m. and 175 lbs. pressure with 26-in. vacuum.

## POWER REQUIRED BY MACHINE TOOLS, WITH SPECIAL REFERENCE TO INDIVIDUAL MOTOR DRIVE.

BY G. M. CAMPBELL.*

This article will not be a theoretical exposition of the subject in general but will rather present a few deductions from the various motor equipments in a modern shop, giving certain curves of power in connection therewith and various examples of every day practice in these shops. Most of the inferences that may be drawn from these records will be left for the reader to make as he sees fit.

There has been a large number of articles written on the amount of power required by machine tools, some of them of but little service but others of the very highest value, and in these articles the horse power required by certain machines varies greatly. This is as might be expected. A certain machine tool, if used to the limit, would require the same horse power in every case, but the same machine in different shops is used for different purposes; in one shop it might be used only for coarse roughing cuts whereas in another it might be used wholly for light finishing cuts; the horse power requirements would be widely different. It is thus necessary to study the special conditions in every instance. In general shops where practically little is done except repair work, such for example as locomotive repair shops, small jobbing concerns, etc., the size of motor required is smaller than would be required for the same tools in ordinary manufacturing shops, and motors in these again would be smaller than would be required for similar tools in large manufacturing shops where the output may be considered practically raw material, but where a certain amount of roughing work is done, for example, mills whose output is car axles, rough turned shafting, armor plate, etc. Tools in such plants would have relatively large capacity motors.

In machine tool work speed variation is essential, and in a machine driven by an individual motor part of the speed variation must be obtained in the motor itself if efficient speed control is required. The range of speed required in some machines may be quite limited, on account of the particular class of work for which the machine is used, and in such a case the full range of speed could be supplied by the motor. On the other hand, the speed variation required may be so great that it is impossible to supply it all by the motor. For example; the 90-in. lathe referred to in Fig. 4 has spindle speed ratios of about 21 to 1, and the 20-in. lathe referred to in Fig. 5 has spindle speed ratios of about 27 to 1. It is therefore necessary to get this speed range changed by proper gearing into such steps that the whole range in each step can be obtained in the motor. In the 20-in. lathe referred to, four runs of gears were used, three changes being necessary to get the total range of 27 to 1 in spindle speed. Calling these gear runs A, B, C, and D; run B would give a spindle speed about three times A; run C about three times B and run D about three times C.

This jump in speed of 300 per cent. in each case is of course inadmissible if taken in one jump, therefore the motor is given a speed variation of about 3 to 1. The machine is running with run of gears A and the motor is at its initial speed, then this speed is gradually increased by any desired increment until the motor is running at about three times its initial speed. At this point the gear run is changed to B and the motor dropped back to its initial speed, the machine spindle would then be revolving at about the same rate as at the high speed run A. A similar change is made to C and to D so that the complete range is obtained in gradual steps with small increments.

Just what range of speed is required in the motor cannot be definitely stated for all conditions. If a total speed range of 6 to 1 is required in a machine, it might be advisable under certain conditions to obtain this total range in the motor, but as a general rule the writer believes it would be advisable to use at least two runs of gears when the speed change required exceeds to 4 to 1, and that a somewhat better and more efficient design can be obtained when the speed change required in the motor is limited to about 3 to 1. The larger the speed range the larger the motor as is shown in Fig. 2, and of course the greater the price, also the disproportion between size of motor and size of machine increases.

The controller necessary to enable the speed change to be obtained in proper increments will vary according to the range required and the size of the increment. It is feasible to work to within 10 per cent. change of speed and consequently a 10 per cent. increment would be desirable. If 10 per cent. increments are used the number of points of the controller would be obtained from the formula:

1. $1^{n-2}$ = Speed range in motor.

Where n is the number of points in controller, "off" point being counted as one point. This would give results as follows:

| Speed Range. | Controller Points. |
|---|---|
| 3 | 14 |
| 4 | 17 |
| 5 | 19 |
| 6 | 21 |

If the motor is a reversing one, then to this number of forward motion points must be added the required number of back motion points; usually one third to one-half the number of forward, so it is seen that the controller would become unwieldly in size or the speed increment would have to be increased above 10 per cent. In the Pittsburgh and Lake Erie shops the speed increment was about 10 per cent. and the speed range required in the motor somewhat less than 3 to 1, the necessary number of runs of gears being used to give the total range in the machine. The maximum number of runs used was four.

This speed change in the motor, which is such a requisite for individual motor drive, may be obtained in several ways, the three principal ones at present being: Multi-voltage or four-wire system; two equal voltage or three-wire system; single voltage or two-wire system. The proper treatment of these various systems would require a paper in itself and cannot be dealt with here. In all the systems the size of motor required is about the same. For certain classes of work one system may be better than another; for reciprocating machine tools, for instance, the multi-voltage system is undoubtedly advantageous. Another very strong point in favor of the multi-voltage system is that standard motors are used, so that repairs can be easily made without danger of mistake in mixing armatures and fields. This system, however, labors under two disadvantages. First, the power house machinery and the distribution lines are somewhat more complicated than the other systems, but though this is a disadvantage it is very greatly overestimated. Second, it is comparatively inflexible compared to a two-wire system. Any two-wire installation already in service can incorporate without any trouble any number of variable speed single voltage motors, whereas before a single motor operated on the multi-voltage system can be put into service, a three part balancer, or motor generator set, has to be installed and also special wiring from power house to motor. This is a great disadvantage and one almost fatal to the expansion of multi-voltage control. The three-wire system is a cross between a multi-voltage and a two-wire, with part of the good points and part of the bad points of each. At the Pittsburgh and Lake Erie shops the multi-voltage system is in use, and at the time it was installed, 1902-3, it was undoubtedly the best system on the market. It has fulfilled all expectations and gives accurately the speed control required, and, owing to the substantial manner in which it was installed, has been maintained at a minimum cost. As to the future, the writer is of the opinion that the single voltage system will predominate.

One factor which has a decided bearing, not on the amount of power required by the tool but on the power or size of the motor to be provided, is the variation in speed required. In determining the size of the motor for a variable speed machine, it must be borne in mind that as the speed range increases the size of motor also increases for a certain horse power output throughout the range, and it must be distinctly

*From a paper read before the Mechanical Section of Engineers' Society of Western Pennsylvania.

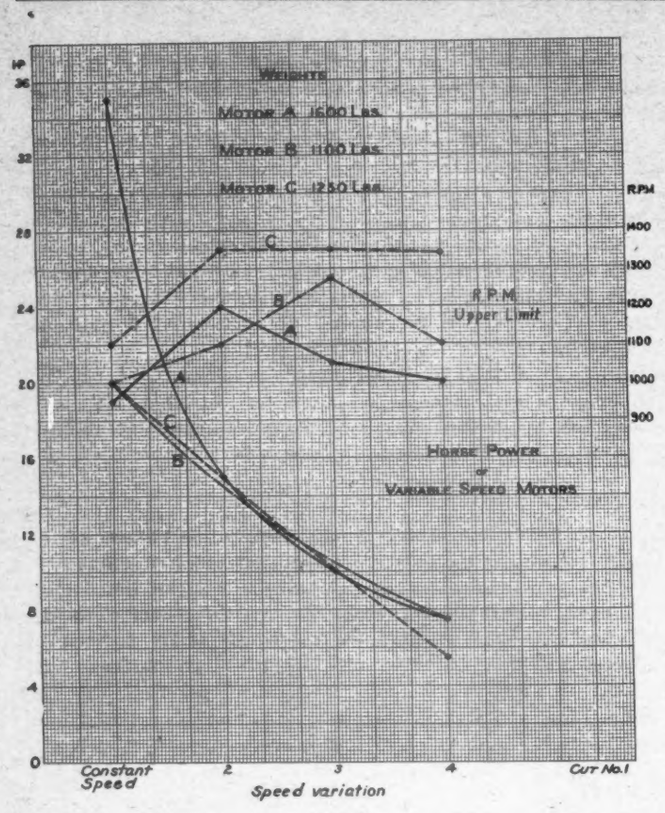



FIG. 1.

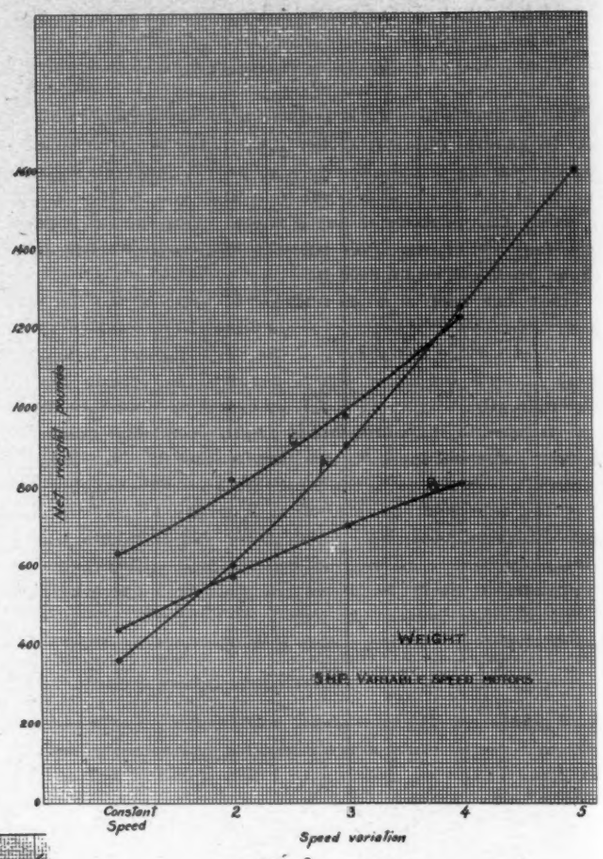



FIG. 2.

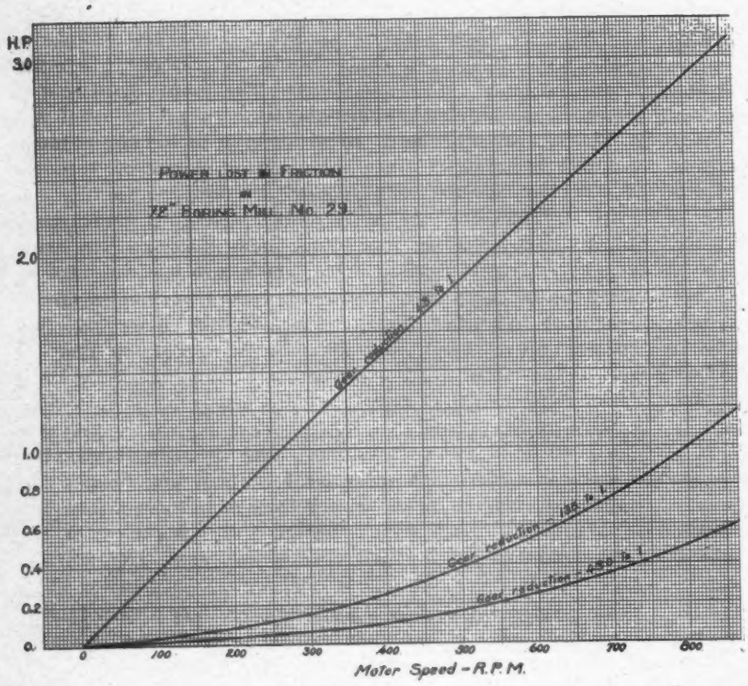



FIG. 3.

more in proportion to its weight, but the drop from 35 to 15 h.p. when a 2 to 1 ratio is required is very great, whereas, in the other two motors the drop from 20 to 15 is proportionately small. Motor A would be sold to one customer as a 35 h.p. constant speed motor and to another as a 7½ h.p., 4 to 1 variable speed motor, but the two prices would be practically identical.

If, on the other hand, a certain horse power is required then from Fig. 2 it may be seen how the weight (also the price though not in the same ratio) will vary as the speed variation changes. When the motor is to run at constant speed a 5 h.p. motor, of a certain make, curve A would weigh about 360 lbs. without rail base or pulley, whereas the same capacity motor but with a speed variation of 5 to 1 would weigh 1,600 lbs., being then the motor given by curves A and B in Fig. 1. Curve B is for the same capacity interpolar motor, of another make, weight ranging from 430 lbs., constant speed, to 810 lbs. at 4 to 1 range of speed. Curve C is for a three-wire motor, weight ranging from 625 to 1,225 lbs. These particular motors are taken simply as examples; understood that a 5 h.p. motor with a 2 to 1 range of speed is an entirely different motor from a 5 h.p. motor with a 6 to 1 range of speed. Manufacturers advertise that they can provide variable speed motors with a speed range of, say, 5 to 1, but they do not at the same time state that they provide perhaps a 30 h.p. motor frame and mark it 5 h. p., that is they provide a size of motor which under ordinary conditions of voltage, field and armature winding would provide 30 h.p. with the standard rise of temperature on 24 hour service.

As an example of this Fig. 1 is given showing the rating for variable speed motors built by three different companies. All three motors are for use on a two-wire system with speed control by field resistance; Motor B is an interpolar motor. When running as a constant speed motor, A has a capacity

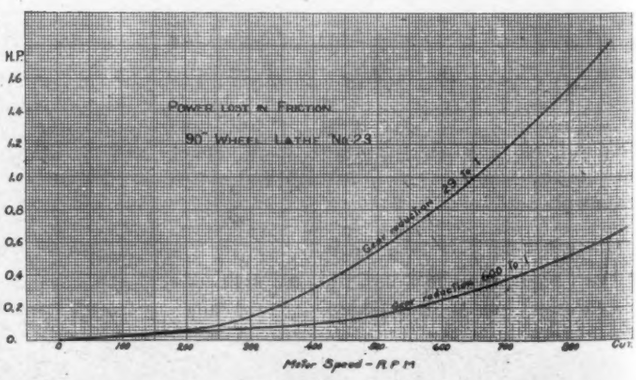



FIG. 4.

the proportions given are special and not general, other types and makes of motors would give different motor curves. The writer does not guarantee the correctness of the figures as published in the manufacturers' catalogs as extracted above. From these examples it is quite evident that when it is stated a certain machine requires, for example, a 5 h.p. motor, such a statement means very little unless the conditions under which the motor is operated or the particular basis on which the motor is rated is given.

Other conditions being the same, the power taken by a machine, after allowance is made for friction losses, will vary

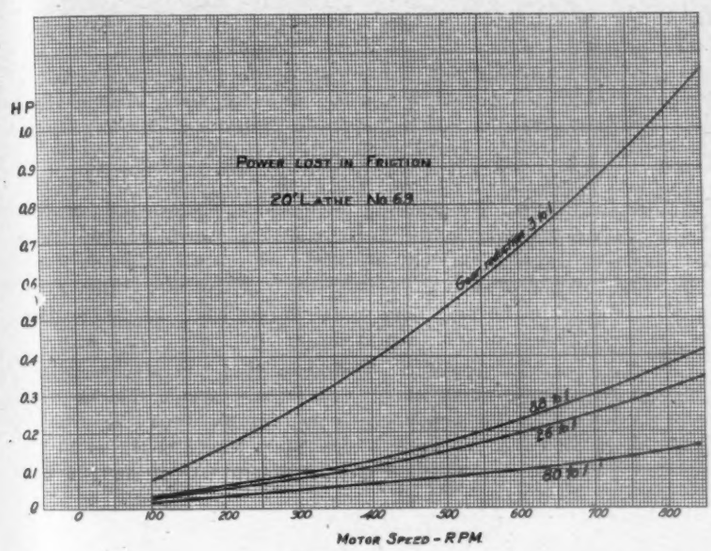



FIG. 5.

approximately as the speed and cut and therefore as the weight of metal removed, consequently in fitting motors to tools due allowance must be made for high speeds and maximum cuts, bearing in mind the coming universal use of high speed tool steels and the increase in rigidity of machines. A formula for the amount of power absorbed in cutting may be stated thus:

$$HP = K W$$

where HP = Horse power
K = A constant, depending on the kind and grade of material.
W = Weight of metal, pounds, removed per minute.

Values of K may be taken as follows:

K = 2.5 for hard steel.
= 2.0 for wrought iron.
= 1.8 for soft steel.
= 1.4 for cast iron.

HARD STEEL.

| Machine. | Cut: Feed Inches | Cut: Depth Inches | Speed Ft. per Min. | Weight Removed Lbs. pr M. | H.P.: Actual | H.P.: From Formula. |
|---|---|---|---|---|---|---|
| 72" Wheel Lathe No. 14. | 1/12 | 3/16 & 1/4 | 13.7 | 1.69 | 4.5 | 4.2 |
| | 1/8 | 3/16 & 1/4 | 11.6 | 2.15 | 6.4 | 5.4 |
| | 3/16 | 5/16 & 3/8 | 13.2 | 5.55 | 8.4 | 13.9 |
| | 5/16 | 3/8 & 3/8 | 13.2 | 6.3 | 12.0 | 15.7 |
| 90" Wheel Lathe No. 23. | 3/16 | 3/16 & 5/16 | 13.0 | 3.1 | 12.0 | 7.7 |
| | 3/16 | 5/16 & 5/16 | 8.8 | 3.5 | 8.1 | 8.7 |
| | 1/8 | 5/16 & 1/4 | 10.5 | 4.0 | 7.3 | 10.0 |
| | 1/8 | 1/4 & 1/4 | 15.5 | 5.3 | 9.0 | 13.2 |
| | 1/8 | 3/8 & 3/8 | 12.3 | 6.3 | 13.4 | 15.7 |
| 19" Slotter No. 77. | 1/32 | 1/4 | 30.0 | 0.8 | 2.0 | 2.0 |
| | 1/32 | 1/4 | 28.8 | 0.76 | 1.7 | 1.9 |
| | | | | | 84.8 | 98.4 |

SOFT STEEL.

| | | | | | | |
|---|---|---|---|---|---|---|
| 60" Planer No. 52. | 1/8 | 1/4 | 25.5 | 3.62 | 5.9 | 6.5 |
| | 1/8 | 1/4 | 25.7 | 3.65 | 6.5 | 6.6 |
| 24" Shaper No. 64. | 1/16 | 3/16 | 26.7 | 1.46 | 3.4 | 2.5 |
| | 1/16 | 1/8 | 37.5 | 1.00 | 2.7 | 1.8 |
| | 1/16 | 1/8 | 41.7 | 1.11 | 2.6 | 2.0 |
| | 1/8 | 1/16 & 1/32 | 44 | 1.76 | 2.9 | 3.2 |
| 72" Boring Mill No. 29. | 3/16 | 1/32 & 1/16 | 40 | 2.38 | 2.6 | 4.3 |
| | 1/8 | 1/8 & 3/8 | 51 | 5.41 | 9.6 | 9.7 |
| | 1/8 | 3/16 & 5/16 | 48 | 7.65 | 12.7 | 13.7 |
| 19" Slotter No. 77. | 1/8 | 3/16 | 47 | 3.75 | 7.2 | 6.8 |
| | 1/32 | 3/8 | 23.3 | 0.93 | 1.3 | 1.7 |
| | 1/32 | 3/8 | 23.3 | 0.93 | 2.1 | 1.7 |
| 42" Lathe No. 10 | 1/16 | 1/4 | 44 | 2.33 | 3.8 | 4.2 |
| | 1/16 | 1/8 | 44 | 1.17 | 1.7 | 1.9 |
| | 1/16 | 1/8 | 44 | 1.17 | 2.6 | 1.9 |

This formula is simply a general one, the power required in any particular case will vary perhaps 100 per cent., according to the condition of the cutting tool. To show how this formula applies, examples in tables* below are given. These examples are taken at random from various machines tested and under ordinary conditions of shop working, they are not results of special tests. The machines, it will be noted, include several different types, some had one tool working, some two. The horse power actually taken for the cut was obtained by deducting from the total power absorbed by the machine the power required to run the machine light at the same speed. This is not quite correct in some cases, for example, in drilling, as will be shown later.

There is considerable discrepancy in some of the figures; that is as might be expected; but in general the agreement is sufficiently close to show that the formula is a reasonable one for arriving at the approximate horse power required for doing the actual work. The readings for hard steel are rather erratic; this is quite natural, as the grade of steel in wheels varies widely; some of the material in that class should evidently be in the soft steel class. The figures for the drill presses are also rather divergent; this is especially the case in drilling, but not so much so in enlarging. The main reason for this is the inaccuracy of the light load losses. The friction loss of the machine running idle is not the same as the friction loss when the machine is working. This friction loss should have been obtained by putting in a non-cutting drill and applying the pressure.

Another factor which enters into the capacity of the motor required is the friction loss of the machine itself. This is a factor impossible to predetermine, but fortunately is not very large except on very large machines; it depends greatly on the gear reduction. A few examples of friction losses will serve to show the general run

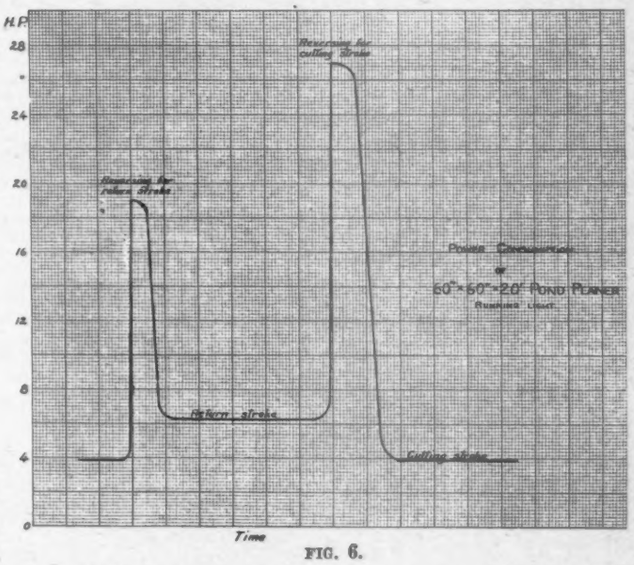



FIG. 6.

of such losses; the power last in other machines may be assumed by comparison.

Fig. 3 shows the power lost in friction in Pittsburgh and Lake Erie tool No. 29, a 72-in. Pond boring mill. There is a difference in lost power in the different gear ratios ranging from 2.9 h.p. for the high speed spindle to 0.5 h.p. for the low speed spindle with motor running at the same speed, 800 revolutions per minute. The spindle speeds for a loss of 0.5 h.p. are 3.14, 4.22 and 1.86, respectively, showing that the loss in friction is not directly proportional either to motor speed or spindle speed. This holds true for all tools.

Fig. 4 is for tool No. 23, a 90-in. Putnam driving wheel lathe. This is quite a large machine, but the friction loss is small, only 1.6 h.p. maximum for high spindle speed and 0.55 h.p. for low spindle speed. Although the gear reductions vary

*Because of lack of space part of these tables only are reproduced here.

considerably, 29 to 1 and 600 to 1, yet the total actual difference in lost power is not very large.

Fig. 5 is for a 20-in. by 11 ft. Putnam lathe, gear reduction varying from 3-1 to 80-1. The maximum loss is about 1.2 h.p.

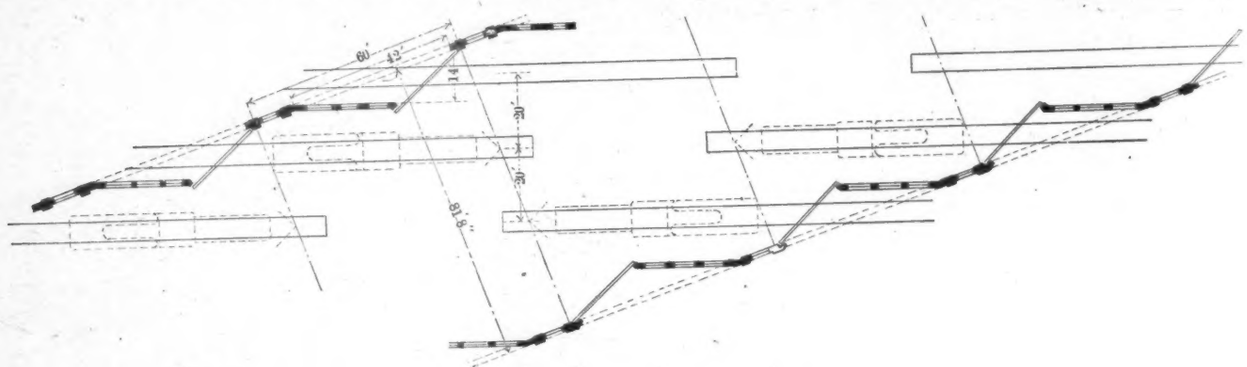
Fig. 6 shows incidentally the power lost in a 60-in. planer; Figs. 8 and 9, in punches; Figs. 15, 16 and 17, in some woodworking tools.

Similar curves could be given for a large number of machines, but these are sufficient to show the general trend of the losses, especially as they show that the losses are small, except when the spindle or table is running at top speed. At the high spindle speed it is rather unlikely that a maximum cut is to be taken, but in all probability only light finishing cuts or polishing, so that in general the power lost in friction in the machine may be neglected in considering the question of size of motor required.

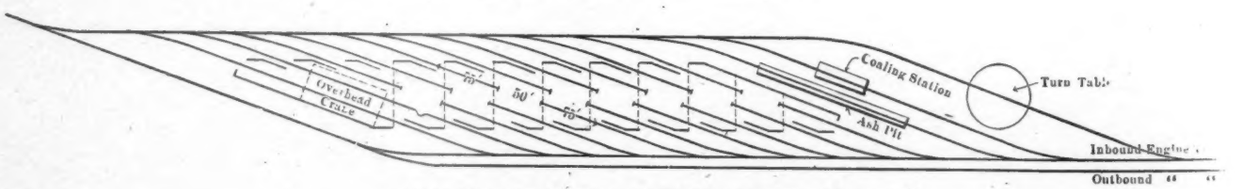
*(To be continued.)*

## A NEW FORM OF ENGINE HOUSE.

The problem of housing locomotives to provide satisfactory storage, facilities for repairs and for quickly handling them into and out of the house, of such form as to be easily heated and ventilated, is one which has taken the attention of railroad men for several years. Several houses of rectangular form have been built and are now in service. These require transfer tables and in order to avoid this and to provide convenient means of extension, a design has been suggested by Mr. J. J. Turner, third vice-president of the Pennsylvania Lines West of Pittsburg, which he has called the Echelon house, the basis of which is a parallelogram. The arrangement illustrated provides a building with tracks running through it, the walls of the building being so constructed as to provide doors for each track, the plan having been developed under the direction of Mr. Trimble, chief engineer of maintenance of way of the Pennsylvania Lines West of Pittsburg. The house itself lies between two parallel tracks and encloses a portion of "ladder" tracks between the main tracks, the house being entered from either side. At one end and outside of the building is a turn-table, a coal station and an ash-pit. At the other end and inside of the building are two tracks running clear through the building, over which an electric travelling crane is located. The other tracks do not extend across an open space at the center of the building, which provides a passage way from end to end. With tracks located at 20-ft. centers considerable space is provided both inside and outside of the house for necessary repair work. The word Echelon is used to designate this construction because of the character of the walls, and the construction used to avoid making the doors too large. It is understood that the idea has not yet been put into the form of construction. It, however, furnishes an interesting study which is now under consideration.




PART PLAN OF ECHELON ENGINE HOUSE.




LAY-OUT OF TRACKS FOR ECHELON ENGINE HOUSE.

## THE REPAIRING OF LOCOMOTIVE FRAMES.

A few years ago the wrought iron frames that have done so well for half a century were universally used. The failure of these was of rare occurrence, and was easily repaired in the blacksmith shop. To-day we have the low carbon cast-steel frame with all its imperfections. Another innovation is the welding of broken frames on the engine with oil for fuel, or with aluminum thermit.

Evidently the steel frame will be the frame for the future, for the reason that it can be produced much cheaper than wrought-iron forged frames. Future developments may bring the steel frame to such a standard that it will resist the strain to which it is subjected as well as the forged wrought-iron frame. From my point of view and the many failures that have come to my notice in the past two years, the steel frame has not yet reached the standard that the wrought-iron frame has. Many of the steel frames break at the intersection of the pedestal to the back bone of the frame where the main driving axle is located. As this failure often takes place with our largest engine frame, it is evident that the severest strain comes at this point, and it cannot be expected that an ordinary weld at this point will be stronger than the original solid material. When a broken steel frame is placed in the blacksmith shop, the best method practical to strengthen this portion of the frame should be adopted, regardless of extra expense. The method adopted in the Southern Pacific shops is to forge a new piece of the best quality of iron and cut out the defective portion; weld in a new "T" piece with the fiber flowing in the direction of the strain to which this portion is subjected. By this method we have to make three welds. This may look like a roundabout way of repairing the fracture. The object is to get a sound piece of iron at the point where failures continually occur in the steel frame. The method adopted for welding the new piece into the steel frame is first to weld a piece of iron about an inch thick on to the different ends of the frame at the proper angle to receive the V-shaped piece. By this method we have for our main welds iron to iron to receive the V-shaped piece.

Recently we have been changing many of our compound

*From a paper read by Mr. S. Uren before the National Railroad Blacksmiths' Association.

locomotives to simple engines. To accomplish this it became necessary to lengthen the front end of the steel frames as shown in Fig. 1. The following method is used at the Sacramento shops to produce the new iron portion. First, the part C, Fig. 1, is produced by lap-welding a T piece, one-half the thickness required, then laying two of these T pieces together as shown at B. They are welded together under a steam hammer after being heated in a reverberatory furnace, producing the shape shown at C, in which the fiber flows in the same direction as the strains. The upper portion of the frame shown at D is made from solid material and with a side projection, which measures about 5 in. The parts C and D are then welded together to produce the forward portion of the wrought-iron frame as shown at E, Fig. 1. This new end is then welded on to the steel portion of the frame as shown in Fig. 2.

When preparing the steel end of the frame for the final weld, a piece of iron is welded on about 1 in. thick as shown at E, Fig. 2. This method leaves the two ends of the parted. The engine returned to the shops and the frames were removed and properly welded in the blacksmith shop. Certainly a good welding heat can be produced by this method in members of frames that are accessible; however, I am opposed to butt welding or any other method of welding in the blacksmith shop, after the iron is brought to a welding heat, without the proper lamination.

Iron, when brought to a high heat, becomes disintegrated. The molecular structure is impaired and lamination is the only method that will produce the original structure. In my opinion the same conditions exist in welding frames on the engine where lamination is impracticable. I coincide with the views of Mr. McCaslin. If the metal has to be brought to a welding heat, the proper place is on the anvil. If a first class weld can be made on a steel or iron frame by this method, the same method would be applicable to other members of the locomotive. I do not think there is a member of this convention who would attempt to weld a main or side rod of an engine by this method.

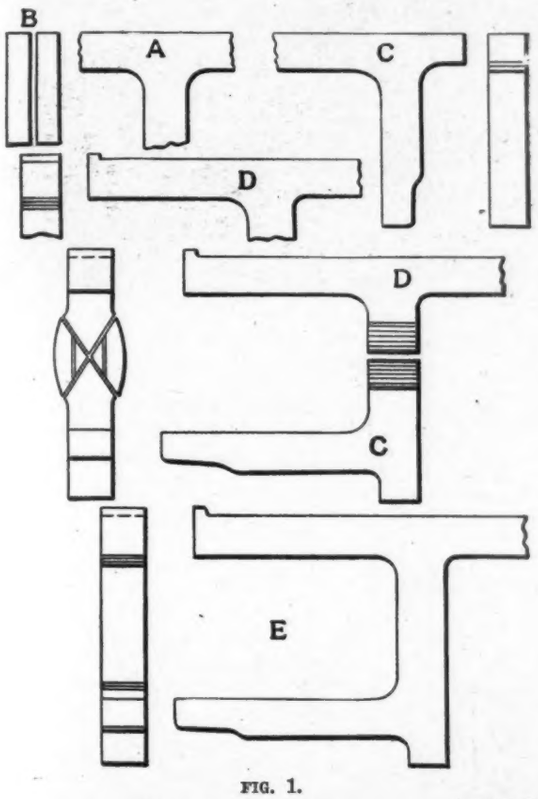



FIG. 1.

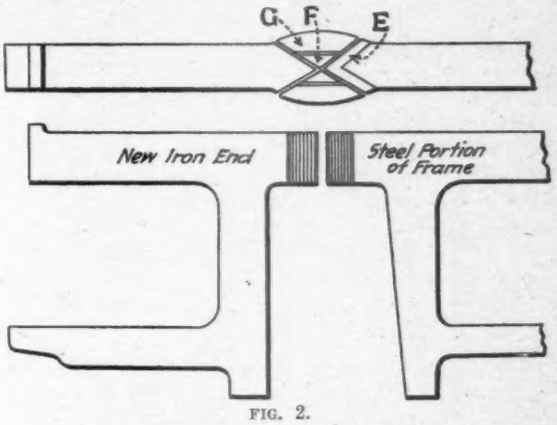



FIG. 2.

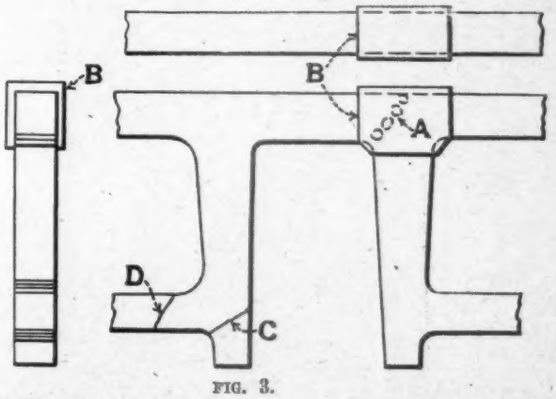



FIG. 3.

REPAIRING LOCOMOTIVE FRAMES.

frame to be welded of the same material and shaped to receive the pieces G and F. The V piece, F, is welded in the cavity for the purpose of insuring a perfect weld in the center of the bar. The piece G is made with an angle of about 110 deg., and when welded into the cavity under the steam hammer is almost equivalent to a lap weld. On our system 40 of these iron to steel frames have been in service a year. Only one has come to the shop broken at the weld. I am under the impression that this break was caused by the steel frame breaking on the opposite side as no sign of the weld presented itself in the fracture.

The welding of frames with oil, without removing them from the engine, has caused me to become somewhat skeptical, as well as many of our members, regarding this method. After reading the report of the committee on this subject, I must concede they have done well; however, it is remarkable that of all the welds noted in the reports which have been made by this method, there has been only one failure. Great claims are made by some of our California shops for this method of repairing frames. I know of several cases of frames welded by this method that have not run ten miles before the welds

Another innovation in the art of blacksmithing is the repairing of frames on the engine by the thermit method. This, above all other methods, is the simplest and quickest, and from my point of view is the best; forge, anvil and steam hammen excepted. At the present time the thermit method is in its experimental stages; it does not require an experienced smith to repair a frame on the engine by this process. The most particular part of making the preparations for the weld is the making of the mold to fit perfectly around the part of the frame to be welded. This is usually done by a moulder. The moulds should be made in halves and bolted together, so that all joints are perfectly tight. By this method of repairing we not only form a perfect union of the broken sections but we can also reinforce the weak points with a collar projecting on each side of the fracture.

The first experiment in the Sacramento shops of mending a frame with thermit was tried April 14, 1905, on engine No. 287, the longest engine on the system. The frame was broken at the junction of the pedestal to the back as shown at A, in Fig. 3. The first preparation made to repair the frame was to drill a series of ⅝ in. holes through the

broken section as shown. The holes being drilled at right angles to each other, produced a number of small facing projections. The ends of these projections were cut off so as to leave a ⅝ in. opening. A jackscrew was then placed between the pedestal, spreading the crack ⅛ in. A wooden pattern was made. This had the same contour as the portion of the frame to be repaired, and had such projections on it as were required to produce the reinforcement desired. Eleven ounces of thermit were placed in the crucible for every cubic inch of space in the mould. The space in the mould for the reinforced portion as well as for the parts to be welded were included in determining the amount of thermit to be used. Before igniting the thermit the ends of the parts to be welded should be warmed with an oil burner. A collar ¾ in. thick, as shown at B, Fig. 3, was left around the broken section. This welded frame has been in service up to the present time without showing the slightest defect, and eight welds have since been made by this process and not one of them has failed.

## HIGH SPEED STEEL TWIST DRILLS.

The following is taken from a paper on "The Practical Use and Economy of High Speed Steel," presented by Mr. J. M. Gledhill, of the Sir W. G. Armstrong, Whitworth & Co., Ltd., before the Glasgow and West of Scotland Foremen Engineers' and Ironworkers' Association.

Perhaps one of the most useful of all the applications following the development of high-speed steel has been the manufacture of twist drills from it. In former days many attempts were made to produce twist drills from the ordinary self-hardening steel with usually but indifferent success.

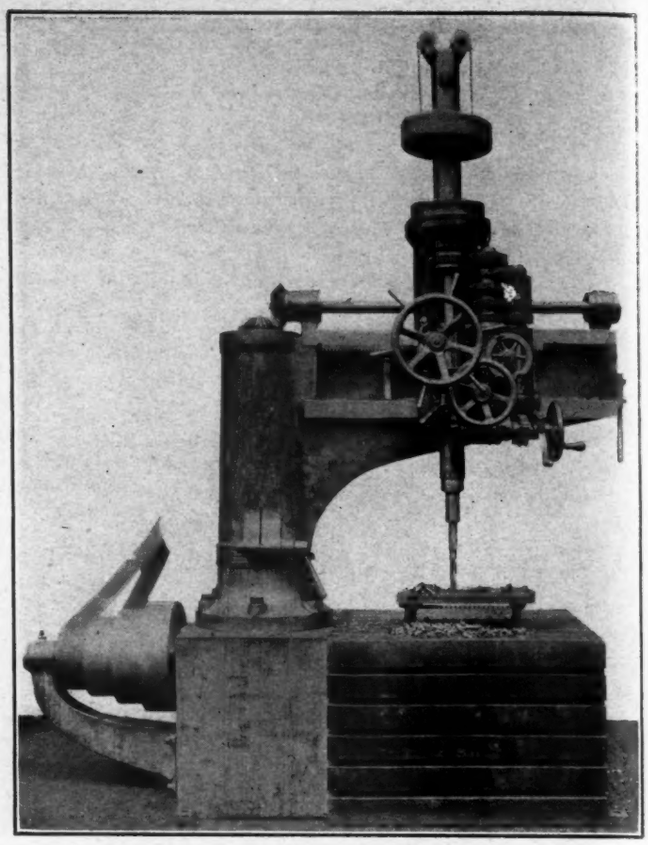


FIG. 1.—HIGH SPEED RADIAL DRILLING MACHINE.

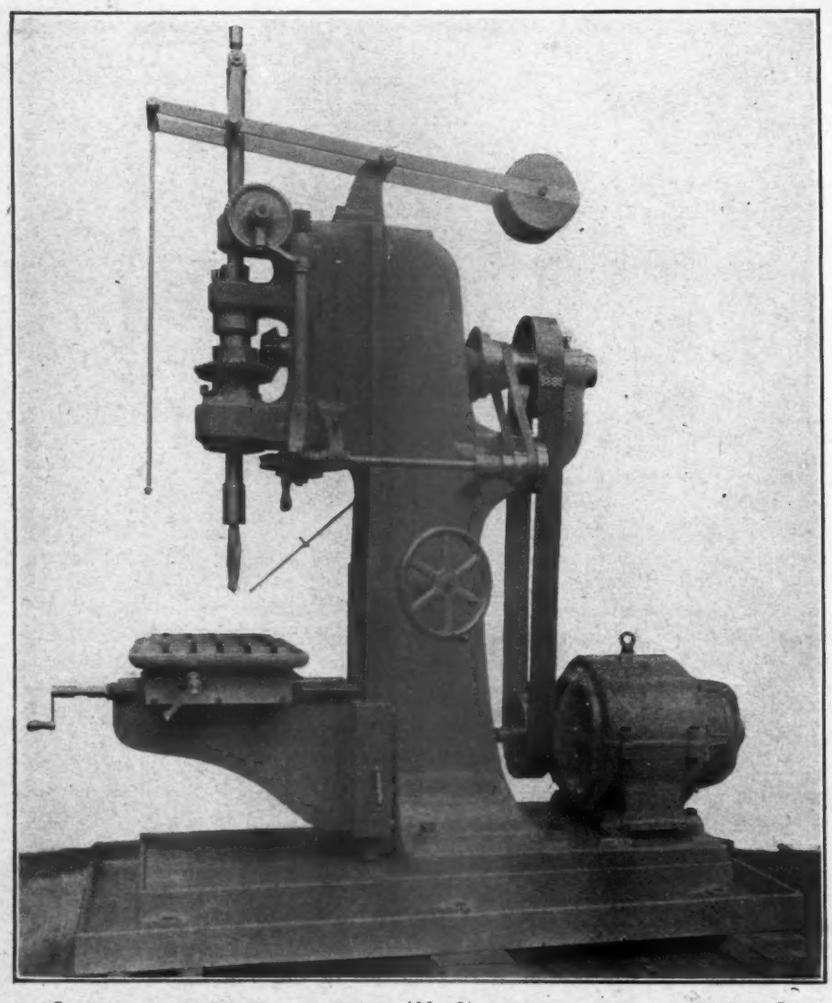


FIG. 3.—HIGH SPEED DRILLING MACHINE—400—¾ INCH HOLES DRILLED THROUGH 3 IN. CAST IRON AT 18 IN. FEED PER MINUTE WITHOUT INJURING DRILL.

Now, however, drills of high-speed steel are to be found in most shops, and it is certainly to the credit of British engineers that they have responded so energetically to the demand for them with the result that they are now sending twist drills of high-speed steel to all parts of the world. This is but another instance of the very rapid progress made with the steel during recent years. At the present time "high-speed drills" are so listed and described; the drills for slower cutting being described as "ordinary." The writer is perhaps not alone in venturing a prophecy that ere long, high-speed drills will be "ordinary," and slow speed drills "special," so special that it will be necessary for one to visit our museums to see them, like the "Rocket" and the "Wooden Walls of old England," good in their day, but their day gone. It certainly is a wonderful sight to see high-speed drills in use, and although the writer cannot vouch for the story that cast iron is being drilled so rapidly that makers of wood working machinery are being called upon to redesign their machines to keep up the race, there is no doubt whatever of the wonderful powers of these drills.

It has been asserted that high-speed drills are rather too expensive except for special use, but figures supplied to the writer by many users and the workshop practice of his firm show that such assertions are not facts. In support and in proof some examples may here be given.

A letter received from a large firm of structural engineers in Glas-

gow who are using "A. W." drills, contained much valuable information from which the following extract is quoted: "Drilling mild steel 2½-in. thickness made of 5 ⅝-in. plates and one ⅝-in. angle iron, a 15/16-in. diameter 'A W.' twist drill, running at 275 r.p.m. with a feed of 75 cuts per inch of penetration, drilled 7,924 holes without requiring regrinding, each hole being drilled in 42 seconds." In another instance "A W." drills were tried drilling mild steel boiler plates at an angle of 1 in 3 to the surface, and after being in use several months the company making the trials announced their entire satisfaction with them.

Referring to the trials made by the writer's firm, these have been of a very severe nature indeed, and were made in a new radial arm machine of their own manufacture designed for using high-speed drills and fitted with positive geared feeds, the width of the driving belt being 5 inches and giving ample power. For the purposes of the trials a number of drills were taken from stock, so that the results would be representative of the capacity of drills usually manufactured. The results show beyond any possible doubt that under ordinary conditions and in suitably designed machines it is practically impossible to break these drills. The machine and the plates drilled are shown in Figs. 1 and 2.

| Diameter and Make of Drill used. | Material Drilled | SPEED. Revs. of Drill per Minute. | SPEED. Cutting Speed feet per Min. | FEED. Cuts per inch of Traverse | FEED. Feed inches per Minute | No. of Holes Drilled. | Condition of Drill. |
|---|---|---|---|---|---|---|---|
| 1 "AW." High Speed | Two ⅞-in. Steel Plates secured together. | 497 | 130.1 | 46 | 10.8 | 50 | Good |
| ¾ " | " | 497 | 97.6 | 46 | 10.8 | 50 | Good |
| ⅝ " | " | 497 | 81.3 | 46 | 10.8 | 50 | Good |
| ½ " | " | 497 | 65.0 | 46 | 10.8 | 50 | Good |
| ⅜ " | " | 497 | 48.8 | 46 | 10.8 | 50 | Good |
| ¼ " | " | 497 | 32.5 | 46 | 10.8 | 28 | End of drill broke |
| 25/32 " | 2-in. Cast Iron Plate. | 630 | 129.0 | 35 | 18 | 400 | Good |

NOTE.—497 revolutions represent the maximum speed of machine.

The trials on cast iron were made at the Liege Exhibition in the machine illustrated in Fig. 3. These results it will be seen show the high-speed drills to possess great torsional strength, for with a feed of 46 cuts per inch (0.21 in. per revolution) when drilling steel of the strength and depth stated, and with the size of drills used, the test in this respect is indeed a severe one. Of course it should not be

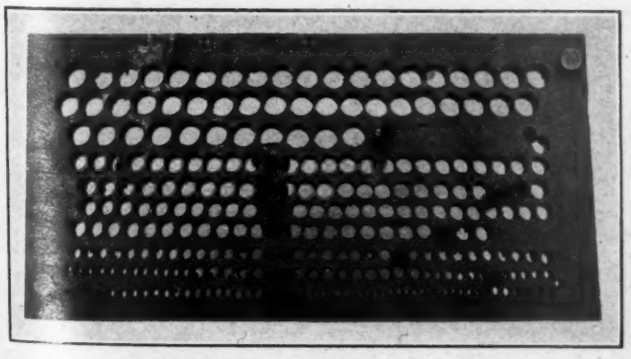


FIG. 2.—TWO ⅞-IN. PLATES BOLTED TOGETHER AND HOLES DRILLED AS PER ABOVE TABLE.

inferred from these results that it is advisable to always work drills at such speeds and feeds, for the latter especially is dependent to a very great extent upon the character of the work being drilled and also the rigidity and excellence of the machine used, and it cannot be expected to obtain such results unless the machines are up to the work the steel will do.

Illustrations of the great superiority of "A W." high-speed drills over the ordinary carbon steel drills are furnished by the examples given below. Drilling the holes in pyrometer test cylinders, at a speed of 240 r.p.m., a drill of ordinary quality drilled 104 holes without grinding, whereas an "A W." drill, used under exactly the same conditions drilled 1,126 holes without grinding, showing an advantage of nearly 5 times in favor of the high-speed drill. The drills are ⅜ in. diameter, used in an automatic machine and drill 1¼ ins. deep through mild steel. When using ordinary drills it was found that they did not withstand the stresses so well as the "A. W." drill.

Quoting from a paper read by a member of an engineering society in a town where a Royal dockyard is situated: "Again with regard to twist drills, another example I noted was with a 1-in. drill on cast iron. A special drill (high-speed) drilled 90 holes at 266 revolutions per minute with a 4-in. feed per minute, through a 4½-in. cast-iron block, and it was practically untouched. A drill of ordinary steel drilled three holes and the end was burnt for about 3 ins. of its length."

## LOCK HANDLE FOR ANGLE COCKS.

There seems to be very little question but that wrecks are caused due to angle cocks used in connection with the train air brake apparatus becoming accidentally closed. This is usually caused by loose train pipes. To prevent accidents of this kind, Messrs. Inches and Hosker, of Kamboys, B. C., have patented a simple lock handle, which is interchangeable with and can readily be substituted for the handle of angle cocks used on the train pipe in connection with the Westinghouse

HANDLE LOCKED IN THE WIDE OPEN POSITION.

air brake apparatus. This handle is so designed that it will be locked when the valve is in the open position unless it is deliberately intended to move it and close the valve.

The body of the stop cock has two lugs or stops, and the ordinary handle has a lug on it which comes in contact with the stops on the body, limiting the travel of the handle to one-quarter of a revolution, and stopping the valve either in a closed or wide-open position. The new handle consists of two parts, as shown in the engravings. One of the illustrations shows the handle in the locked wide-open position, while the

HANDLE UNLOCKED.

other shows the handle unlocked so that the valve may be closed. The detent, or lug E, on the handle comes in contact with a lug or stop on the body when the valve is wide

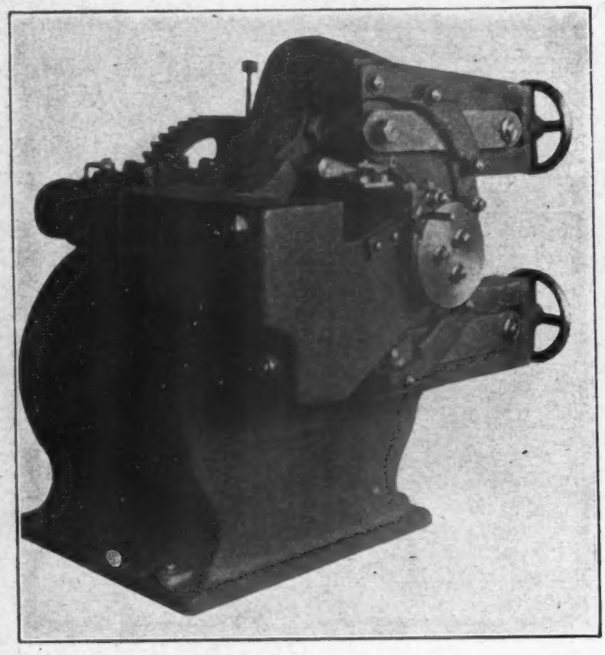
open, which prevents it from being moved beyond this position. When in this position the handle of its own weight drops so that the lug A comes into contact with the stop B on the body of the valve. The handle has a recess which fits down over the lug E. When the handle is in an unlocked position, as shown in one of the views, it may be moved so that the lug E comes into contact with the stop B, thus closing the valve. The backs of the lug A and the stop B are beveled so that when in this position the handle will drop into its normal position, but can readily be moved to the wide-open position.

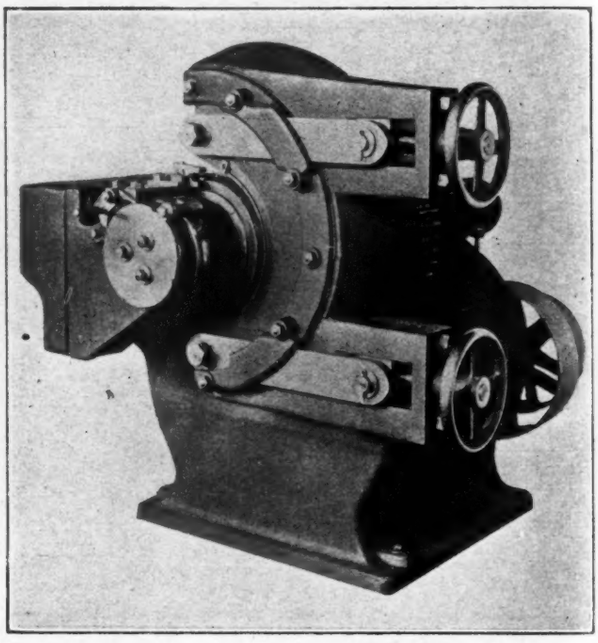
## ACME THREAD ROLLING MACHINE.

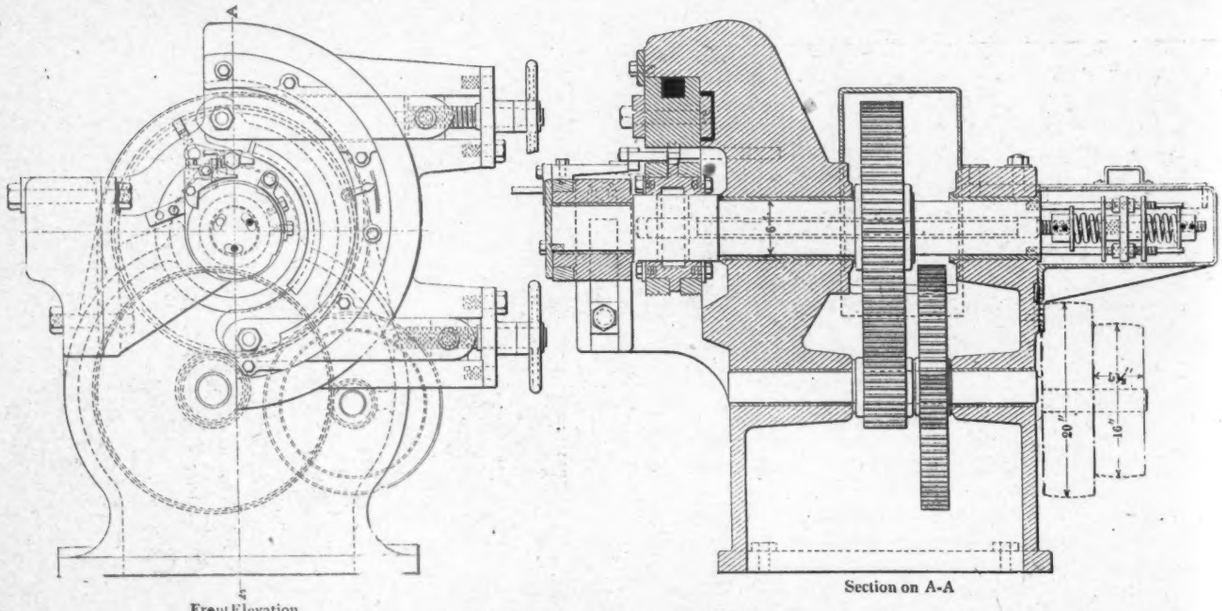
In this machine, made by the Acme Machinery Company, Cleveland, Ohio, the threading dies instead of being of the reciprocating type are composed of one rotary die which runs continuously in one direction and one segmental die which remains stationary after it has been adjusted to the bolt to be threaded. The bolt, or piece that is to have the thread rolled on it, is passed between the two dies and is carried around by the rotating die which is mounted on the main spindle.

The distance between the dies is adjusted by means of the two handwheels shown in the accompanying engravings. The segmental die is carried on a heavy block that is eccentric to the shaft and by loosening one of the handwheels and tightening the other the adjustable die is advanced or withdrawn from the rotary die. In the drawing, showing the die and feed mechanism, A is the rotary die, B the adjustable shoe or block carrying the segmental die and C is the driving spindle. A pointer on the frame and a scale on the segmental die holder indicate the degree of eccentricity and assist in the proper setting of the die. The bolt to be threaded, D, is first placed in the jaws E, then the operator starts the bolt into the machine by moving a handle—extending out from the feeding carriage—attached to the pawl F. This handle, shown in the photographs, drops the pawl into engagement with the notched disk G, which carries the oscillating carriage H forward and passes the work between the dies, the rolling beginning at once; the jaws then open automatically, allowing the carriage to drop back to the feeding position.

There are four opportunities for feeding in every rotation of the die, as there are four notches in the disk. The bolt or rod is fed into the machine horizontally so that bridge rods, car truss rods or other work of almost any length may have threads rolled on the end. It will be seen from the view show-



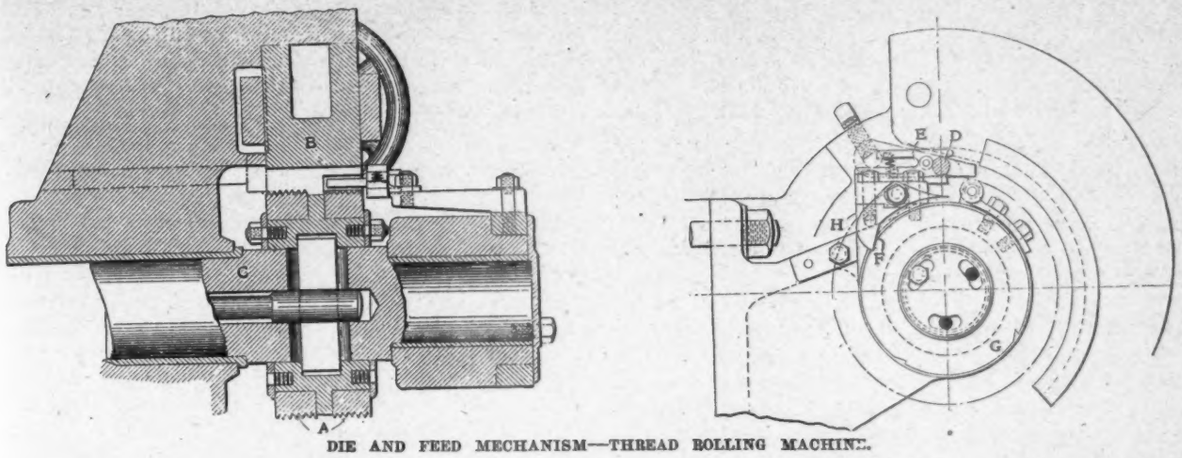




Front Elevation

Section on A-A

ACME THREAD ROLLING MACHINE.




DIE AND FEED MECHANISM—THREAD ROLLING MACHINE.

ing the elevation and section of the machine that at the rear end of the main spindle there are two spiral springs and means for putting them in tension. These keep the dies in pitch. As the bolt enters and the rolling begins at different points on the rotating die, the breaking down or the beginning of the thread is not confined to one particular place. The dies admit of fine adjustment for the required size of work, or to compensate for wear. The adjustment for different diameters with threads of the same pitch is made entirely by varying the setting of the stationary die. For other pitches a different set of dies may readily be substituted. Equipped with two sets of dies, as shown, the machine can be used for rolling studbolts, forming both ends at one operation.

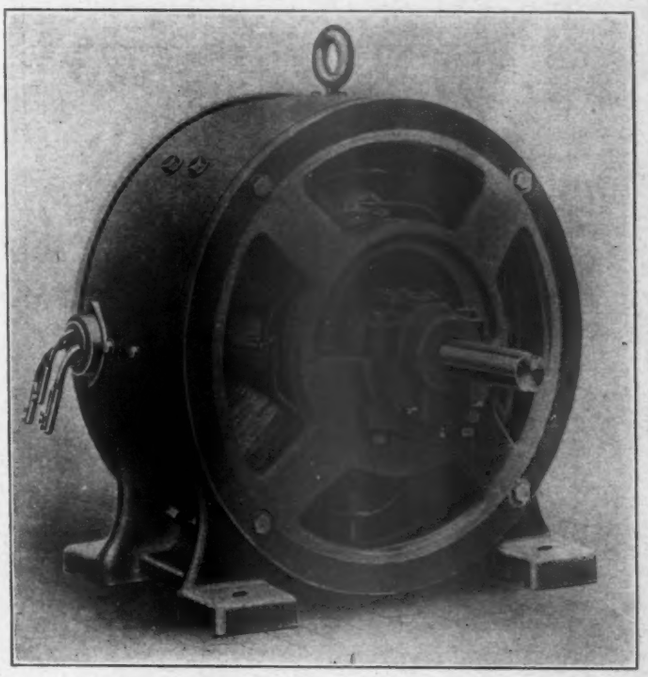
The following results of a recent test illustrate the comparative strength of cut and rolled threads, the material in both cases being machine steel. A 1¾ by 24⅝-in. bolt with cut thread showed a tensile strength of 88,900 lbs., while a 1½ by 24⅝-in. bolt with a rolled thread showed a tensile strength of 95,850 lbs. The rolled thread is, of course, not adaptable for every purpose, still the above test shows that where it may be used there is a considerable gain in strength and a consequent saving of weight and cost. A saving in time is also said to be effected, as at least twice as many bolts may be rolled as may be cut in the same time. These machines are made in two sizes, one rolling threads up to 1 in. in diameter and the other threads up to 2 ins.

## WESTINGHOUSE AUXILIARY-POLE DIRECT CURRENT MOTOR.

Many classes of work require a wide speed variation, and to meet this demand the Westinghouse Electric & Manufacturing Company has developed a line of direct current motors, known as type SA, which by means of field control have a speed variation of 4 to 1 on a single voltage.

The new motors are similar mechanically and electrically to the Westinghouse type S motors, except for the addition of auxiliary poles and coils. These are introduced in order to control the field form during the variation of field strength necessary to obtain so wide a range of speed. The cast steel poles with machine-formed coils are placed midway between the main poles and securely bolted to the frame. The construction is very simple, and introduces no complications, nor does it make difficult the removal of the main poles and field coils, as is evidenced by the fact that an auxiliary pole and coil can easily be taken out, without in any way disturbing the main field winding, by simply disconnecting the coil connections, withdrawing the bolts which hold the pole to the frame and sliding the pole and coil out parallel to the shaft.

The auxiliary field winding is connected in series with the armature and produces a magnetizing effect which is proportional to the armature current. The auxiliary coils are placed as close to the armature surface as mechanical considerations will permit, and their turns are concentrated at that point. This arrangement adds materially to the performance of the motor, as it applies the corrective influences of the auxiliary winding at the points where the distorting effect of the armature current is strongest. This arrangement is much more effective than where the ampere turns are distributed along the length of the auxiliary poles. The magnetic field of the auxiliary winding acts in direct opposition to that produced by the armature current. The resultant field is made up of three components—that due to the shunt winding, that due to armature reaction, and that due to the auxiliary windings. The field distortion usually produced by armature reaction is therefore overcome, and the shape of the



AUXILIARY-POLE DIRECT CURRENT MOTOR.

magnetic field at the point of commutation is maintained as formed by the main poles, and good commutation is made possible over a wide range of speed.

Type SA motors are shunt wound, and thus have a definite speed for each point of the controller which is nearly constant for all loads. Heavy overloads may be momentarily developed without injurious sparking. The motors are reversible without danger and without readjustment of the brushes. As the armature and auxiliary windings are connected permanently in series, it is only necessary to change the external armature connections to reverse the direction of rotation. These motors develop their full rated output throughout the entire range of speed. They will carry full

rated load at any speed within their range for six hours with a temperature rise not exceeding 40 deg. C. in armature and field, and not exceeding 45 deg. C. on the commutator, as measured by thermometer. At all loads and all speeds commutation is excellent, and an overload of 25 per cent. may be carried for one hour without injurious sparking. Their efficiency is high and their speed regulation practically exact. With the exceptions noted, type SA motors are mechanically identical with the type S, and corresponding parts are interchangeable.

## TESTS OF HIGH SPEED TOOL STEEL ON CAST IRON.

During the past year the engineering experimental station of the University of Illinois has been carrying on an extensive series of tests with high-speed tool steels, cutting cast iron, to determine the variation of the cutting force with the area of the cut; the variation of the durability of the tool with the cutting speed and the variation of the advisable cutting speed with the hardness of the iron. The following summary of results is taken from a bulletin issued by the University of Illinois and prepared by Professor L. P. Breckenridge and Mr. Henry B. Dirks.

The horse power lost in driving the lathe and countershaft

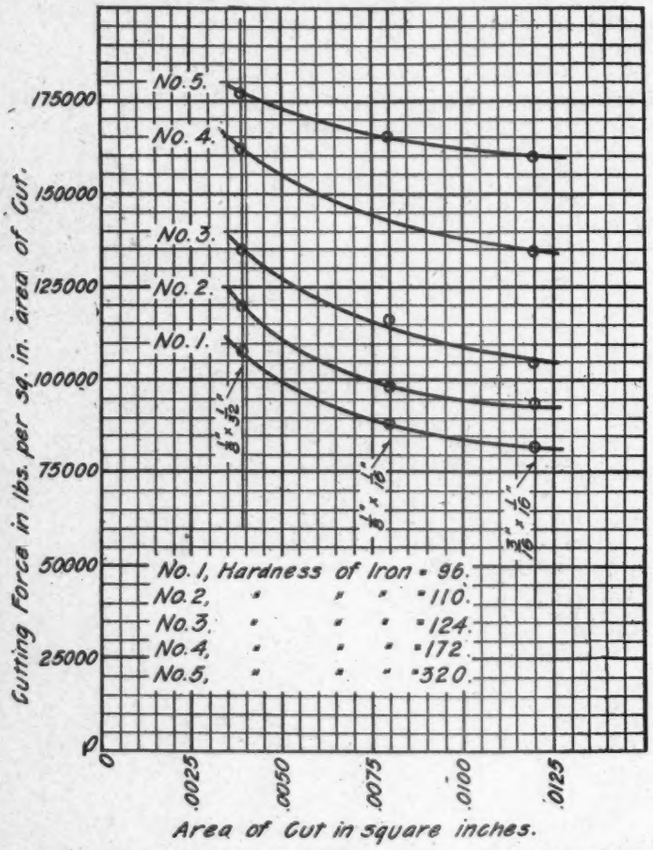



FIG. 1.—SHOWING RELATION BETWEEN CUTTING FORCE ON POINT OF TOOL AND AREA OF CUT FOR CAST IRON OF VARYING HARDNESS.

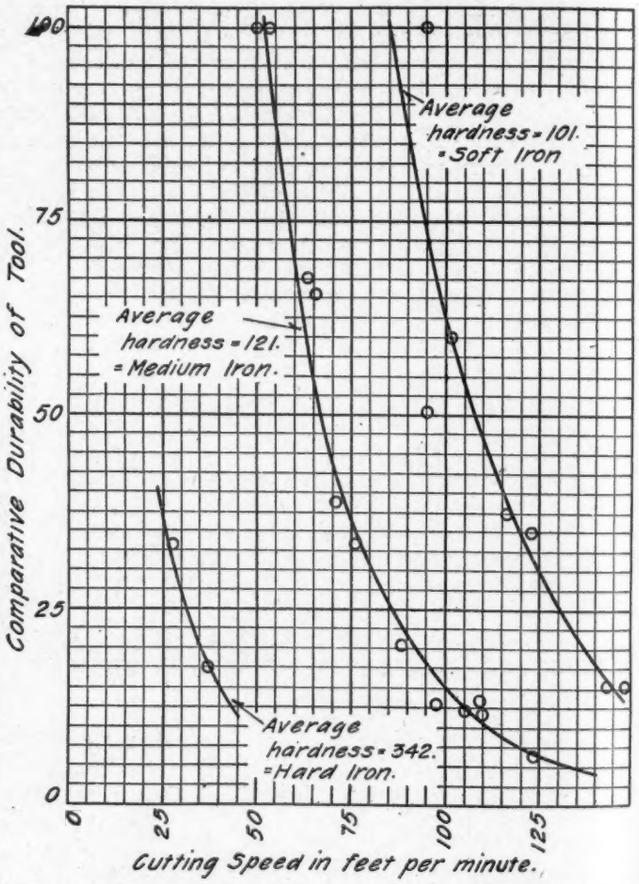


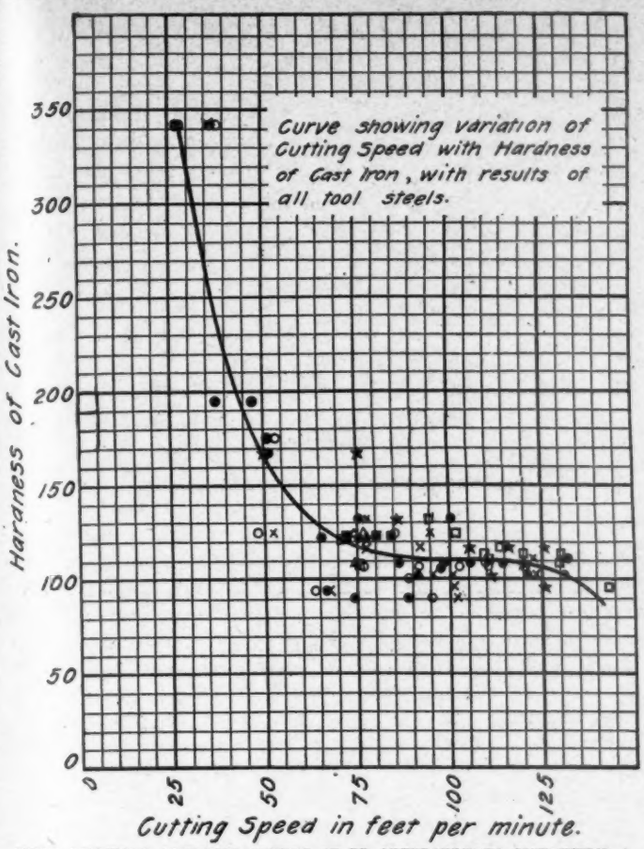

FIG. 2.—SHOWING VARIATION OF DURABILITY OF TOOL WITH CUTTING SPEED FOR CAST IRON OF VARYING HARDNESS.

was deducted from the total horse power used during the trial, the difference being the net horse power required for cutting. This was reduced to foot-pounds per minute, and divided by the cutting speed, giving the force exerted. The figures so obtained were reduced to pounds per unit area of cut, and plotted as ordinates upon a base of area of cut in Fig. 1. The curves show that the cutting force was not directly proportional to the area of cut, but decreased as the area increased, and that the average cutting force varied from 50 tons per square inch for soft iron to 85 tons per square inch for hard cast iron. Each curve shown in the figure represents a different hardness of cast iron. The relative hardness is shown in the table on the figure.

In Fig. 2 are shown the curves which represent the relation between the durability of the tool and the cutting speed. These are important curves. Each one represents a different hardness of cast iron. Referring to the middle curve, which is for cast iron of medium hardness, it will be seen that a cutting speed of 50 ft. per minute is satisfactory, the durability being 100. If the speed is increased very materially, the durability decreases quite rapidly. It is evident that for each hardness of cast iron the cutting speed allowable for a maximum durability exists where the vertical line indicating cutting speed is tangent to curves similar to those drawn.

The curve shown in Fig. 3 represents the advisable cutting speed on cast iron of varying hardness. This curve represents the result of all the tests of the different steels tested. It shows: (a) that any of the steels can remove very hard cast iron at a rate of 25 ft. per minute; (b) that all of the steels tested begin to wear rapidly at speeds a little above 125 ft. per minute. Between these two points the relation between a safe cutting speed and the hardness of the cast iron seems to be definitely expressed by the curve. It would seem that cast iron of medium hardness, 100 to 120, could be cut at 125 feet per minute just as readily as at 70 ft. per minute, as far as any injury to the tool is concerned. It must be remembered that this curve does not take into account the effect, on the cutting speed, of the variation in the area of the cut; the experiments from which the curve was plotted were in all cases those in which the cut was very nearly ⅛ in. deep by 1-16 in. feed, so that there is but a slight variation in the area of cut in all of the experiments. In order that any company may make use of the curve shown in this figure, it will be necessary simply to determine the average hardness of its cast iron, as explained elsewhere, and where the horizontal line representing this hardness cuts the curve, the possible safe cutting speed may be read on the scale below. This curve should prove useful to manufacturers.

General speaking, all the steels tested proved equally effective. It is very evident that there are great possibilities ahead for high-speed steels. Before realizing their full bene-




CURVE SHOWING CUTTING SPEEDS IT IS ADVISABLE TO USE WITH A VARIATION IN THE HARDNESS OF CAST IRON.

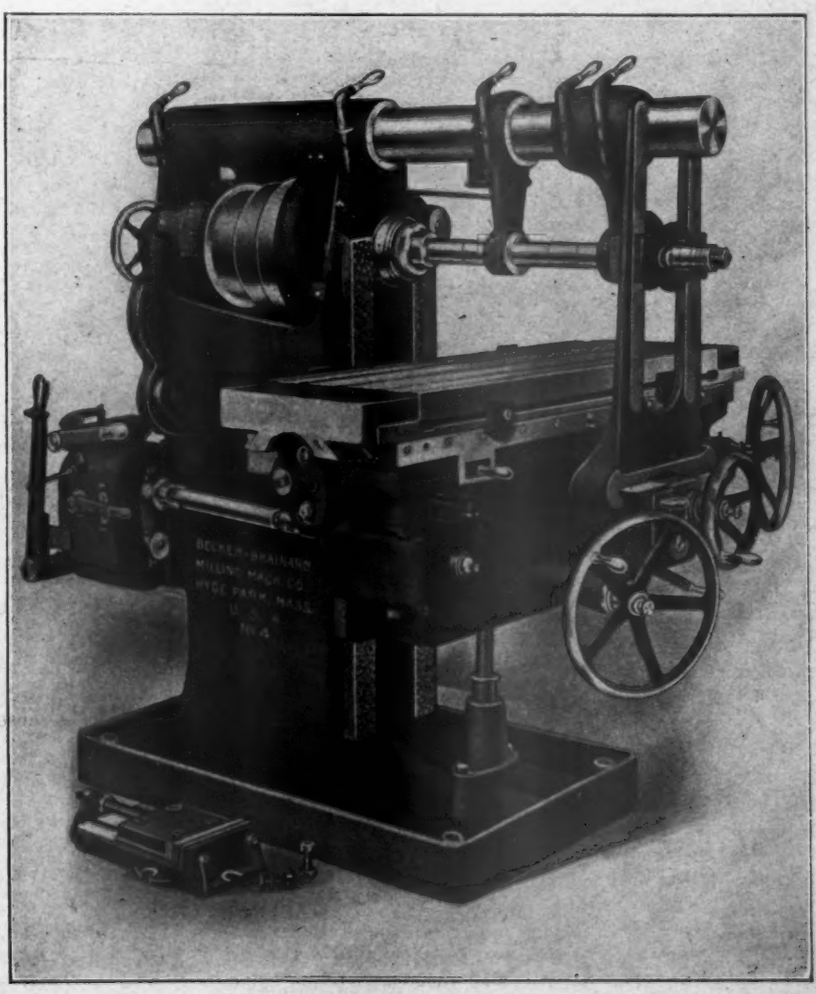
fit, however, certain advances must be made. Heavier machine tools must be built. The capacity of the motors and power plants must be increased. Special hardening furnaces with temperature measuring devices must be available. More must be known concerning the chemical and physical properties of the various steels. Tool steels are now available that will cut cast iron from two to three times as fast as was possible a few years ago. When every advantage has been taken of these possibilities the cost of manufacturing many articles should be materially reduced.

MODERN MACHINE TOOLS AND RAILROAD SHOP WORK.—The machine of to-day, aside from its inherent strength, is equipped with speed and feed adjustment attachments which are immensely valuable. These are no uncertain improvements tending to increased ease, accuracy and speed of output. I do not question the need of strength in the machine itself, but I do question the value of the results we get from a blind use of these machines. To be sure, if there is an excessive amount of stock to be removed from any piece to be finished, the rational method is to crowd on power and get it off, but my contention is this: In the average run of railroad machine shop work the excessive stock for finishing should not be there. Excessive stock means unnecessary initial expense for castings or forgings. Excessive stock on castings indicates poor pattern design or the use of one pattern to fill several sizes needed at a consequent saving in pattern shop labor, but a heavy increase in resultant net cost of output.—*Mr. C. J. Crowley, Western Railway Club.*

## NEW PLAIN MILLING MACHINE.

The Becker-Brainard No. 4 plain milling machine with gear feed, illustrated herewith, has, among other important new features, a positive gear feed drive and change feed mechanism, by which 20 changes of feed may be made without stopping the machine; also a new clutch mechanism in connection with the hand wheels, which prevents any accidental change from their fixed positions, and also prevents them from revolving when the automatic feeds are thrown in; the knee is of the box type, and is equipped with a telescopic elevating screw. The spindle, which is made from hammered crucible steel, has a ¾-in. hole through its entire length, and runs in self-centering bronze boxes arranged to compensate for wear. It has a slot across the end to engage the clutch on the arbor, and is threaded to take a chuck, a threaded collar covering the screw when not in use. The spindle is double back geared, the gears being protected by guards. The driving cone has three steps, and this in addition to the double back gears furnishes 18 different spindle speeds having a range of from 18 to 220 r.p.m.

The patented change feed mechanism is connected with the spindle by three spur gears. It is arranged on the back of the column, as shown, and by a simple movement of the levers any one of 20 changes of feed, ranging from .008 ins. to .366 ins. per revolution of the spindle, may instantly be obtained without stopping the machine. The overhanging arm is of steel 5 ins. in diameter, may be adjusted horizontally, and has an arbor support, which may be removed so that any of the attachments may be placed in position without removing the arm. The distance from the center of the spindle to this arm is 8¼ ins. The table has a working surface of 16½ by 48 ins.; has a longitudinal feed of 46 ins. and a power cross feed of 14 ins. The feeds may be reversed from the front of the



BECKER-BRAINARD MILLING MACHINE.

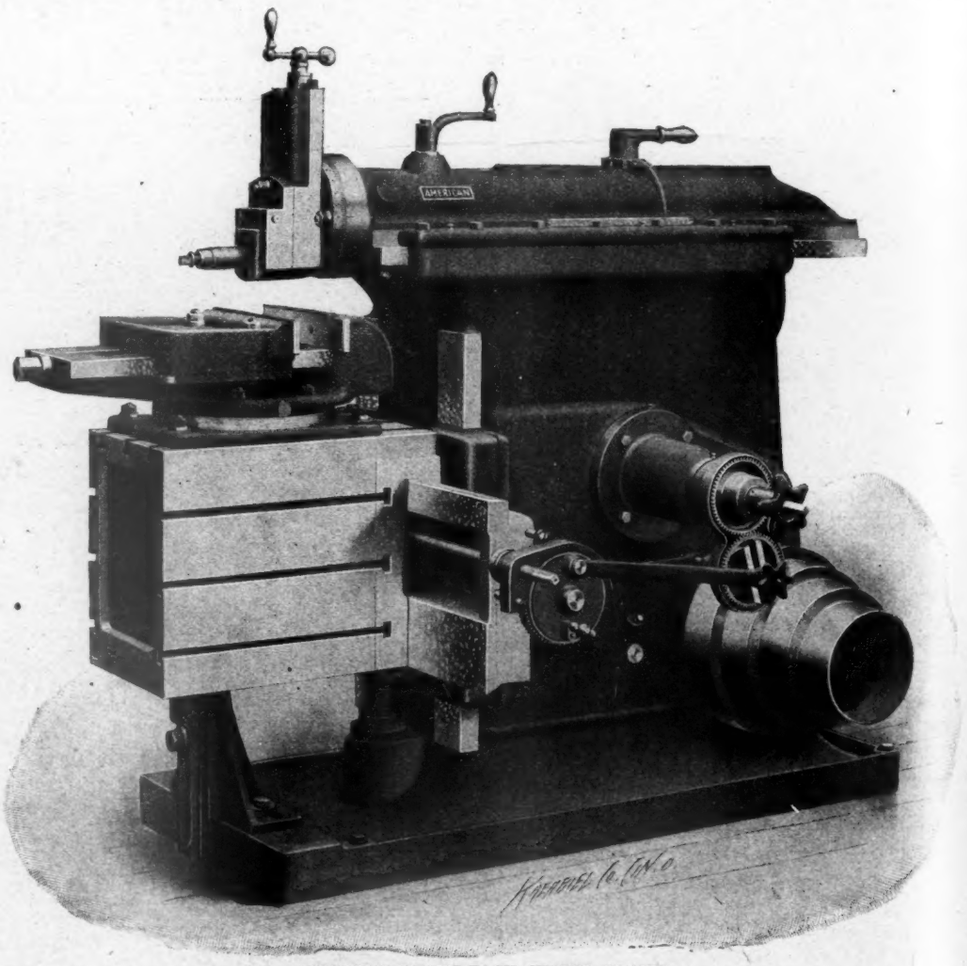
machine. The knee, which is of the box type, is supported by a telescopic screw. It is provided with an automatic vertical feed and knock-off.

The clutch arrangement, which is provided with the hand wheels for operating the feeds, is enclosed in a hub. When the table has been set to the required position the clutch may instantly be disengaged by pressing in the knob on the front of the handwheels. Dials, which are adjustable and are graduated to read to thousandths of an inch to indicate the vertical, transverse and the longitudinal movements of the platen, are set in position with a set screw. The net weight of the machine is 7,100 lbs.

## HEAVY BACK GEARED SHAPER.

The American Tool Works Company of Cincinnati is getting out a new line of extra heavy and powerful shapers ranging in size from a 16 to a 28-in. stroke. The general design of these machines is similar to that of the 28-in. shaper shown in the illustration. In a recent test one of these machines took a cut in cast iron ½-in. deep, 5-32-in. feed, with the highest speed of the back gears and the belt running on the smallest step of the cone pulley; under similar conditions a cut ½ in. deep, 5-64 in. feed, was taken in tough machine steel.

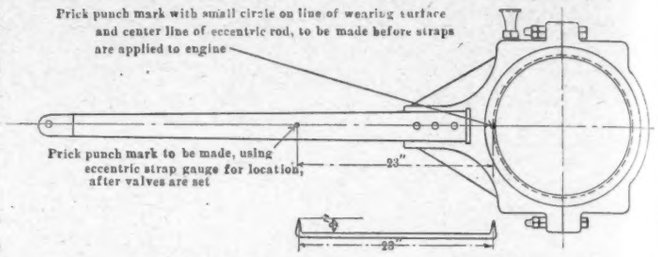
The column is deep and wide, tapers slightly toward the top and is strongly braced internally. On the outside the column is reinforced by a wide, deep rib, and is extended at the top to both the front and the rear, to provide a long bearing for the ram. The ram is designed for uniform strength at all points of the stroke, and has eight changes of speed ranging from 15 to 181½ ft. per minute with the machine running full stroke. The stroke may be adjusted while the machine is in motion. The rocker arm is pivoted near the base line, giving the ram an almost uniform rate of speed for its entire stroke and providing a very quick return. Change may be made from single to back gears by means of a convenient lever. The back gear ratio is 1 to 29.4, and the maximum length of stroke is 28½ ins. The rocker arm is bifurcated at the top, and this, with the opening through the column, provides for the key seating of shafts up to 3½ ins. in diameter. The head swivels to an angle of 50 deg. on either side of the vertical and has an improved locking device. The down feed has a traverse of 9 ins., and the feed screw has an adjustable graduated collar reading to .001 in. The table is fitted to the apron by an improved method, insuring accuracy and stiffness, and is detachable. The vertical travel of the table is 13¾ ins., the horizontal travel is 31 ins. The telescopic elevating screw has ball bearings. The cross feed is variable and automatic, having a range of .0114 to .25 in. The feed may be reversed without stopping the machine.




AMERICAN HEAVY BACK GEARED SHAPER.

## CONVENIENT METHOD OF VALVE SETTING.

In case an eccentric strap is sent to some outlying roundhouse to replace a broken one, with this arrangement it is not necessary to send an expert valve setter to set the valves. This scheme was put into effect about five years ago by Mr


Prick punch mark with small circle on line of wearing surface and center line of eccentric rod, to be made before straps are applied to engine
Prick punch mark to be made, using eccentric strap gauge for location, after valves are set
23"
23"

CONVENIENT METHOD OF VALVE SETTING.

J. S. Turner, then superintendent of motive power of the Fitchburg Railroad. All eccentric straps as soon as finished on the machines, and before being placed in stock, were marked opposite the wearing surface, on both sides of the face, next to the eccentric rod fit, with a prick punch, the mark being inclosed on each side in a circle, so as to be easily found. As engines pass through the shops for repairs a standard tram was used after the valves had been set and tested, and all eccentric rods were marked with this tram, as shown in the engraving. In case an eccentric strap was broken or cracked upon these engines, the man making the repairs bolted the rod to the strap, using a standard tram, and when the rod was secured in place the valves were square because the tram points were placed at precisely the same distance apart as when the valves were originally set before

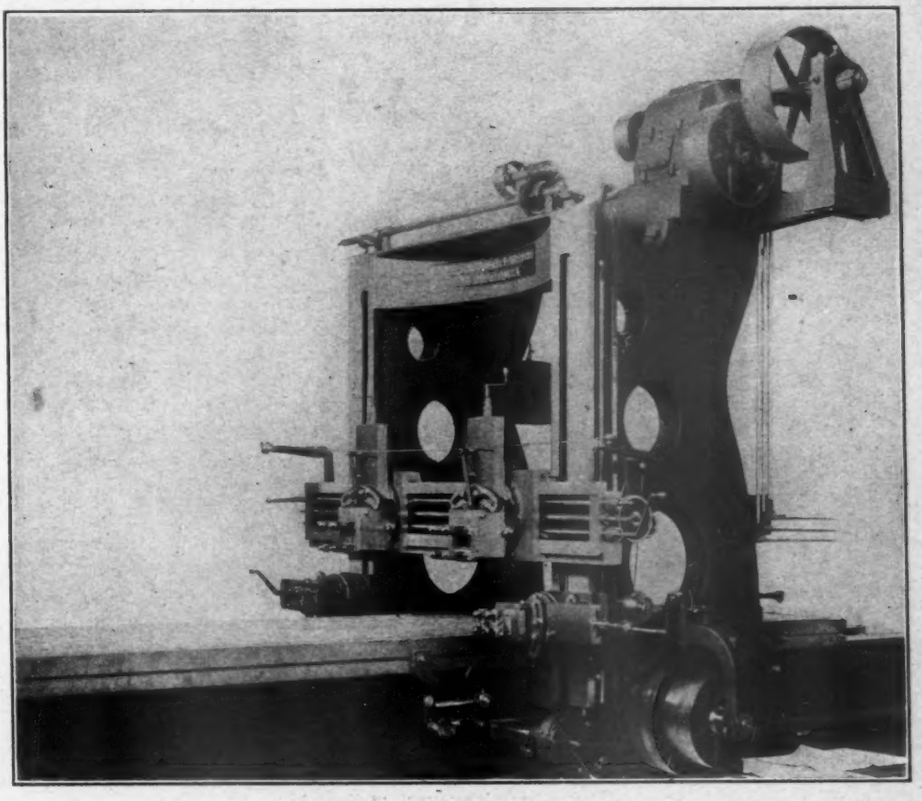
the engine left the shop. Assuming that the valves were perfectly "square" before the strap was broken, this method permitted of putting an engine into the same condition with a new eccentric without requiring skilled labor. Because of requests for information as to this method, Mr. J. S. Turner has kindly supplied the information for this description.

## 72-INCH IMPROVED CINCINNATI PLANER.

The Cincinnati Planer Company recently furnished the Trenton, N. J., shops of the Pennsylvania Railroad with one of their standard 72 by 72-in. by 18-ft. planers, equipped with four heads, a variable speed box, an automatic tool lifting device and arranged for a motor drive. The speed box is arranged for six cutting speeds (20, 25, 30, 35, 40 and 45 ft. per minute), and a constant return speed. The planer is driven by a 30-h.p. Westinghouse motor (not in place when the photograph was taken), which is mounted above the housings in the same manner as the application to the 42-in. forge planer shown on page 303 of the August, 1905, issue.

The bed of the machine is made of extra length, so that there is very little overhang of the table when planing at full stroke. The table is very deep, is thoroughly ribbed underneath and has a complete shifting mechanism on each side. The housings are carried down to the floor and in addition to being fastened by the usual bolts and dowel pins are secured by a long tongue and groove. The heads are of a new shape, the end of the tool block and slide being made round to avoid projecting corners on angular work. The slides are hung on ball bearings. The side heads have an independent power and hand vertical feed, and may be run below the top of the table when not in use. The handles, which control the feeds for these heads, travel up and down with them and are always convenient to the operator.

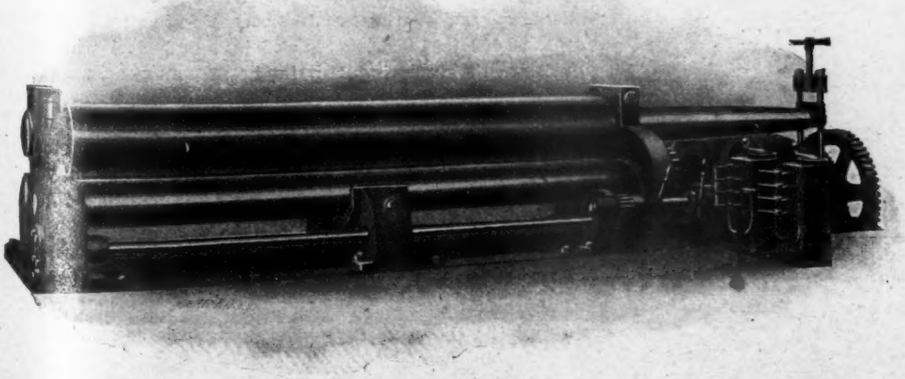
The cross rail, as may be seen, has a very long bearing on the housing, and is strengthened by an arch-shaped brace at the back. The cross rail is raised and lowered by means of a patent device, which was described on page 194 of our May, 1904, journal. It is located in the center of the arch, thus providing a third bearing for the elevating shaft and distributing the pull equally. The shifter is provided with a safety locking device, which prevents the table from starting except at the will of the operator. The rear dog is fitted with a latch so that when desired the table may be run from under the cutting tool.



IMPROVED 72-INCH CINCINNATI PLANER.

## MOTOR-DRIVEN BENDING ROLLS.

The accompanying illustration shows a large Bement, Miles & Company No. 7 plate bending machine, which is driven by a 20-h.p. semi-enclosed Crocker-Wheeler motor. The lower rolls are 11 inches in diameter, have a central bearing, and are driven positively through gearing in either direction. The motor is so designed as to meet the heavy strains incident to this class of work, and although it is partially enclosed for the protection of vital parts it has sufficient openings to provide for good ventilation and access to the internal parts. The upper roll of the machine is 16½ inches in diameter, and is extended to receive the pressure of a screw bearing which supports the roll when the jointed bearing at the other end is removed to allow a circle or flue to be taken off. The lower rolls are stationary, and the two ends of the top roll have a vertical adjustment, either individually or together, through worm gearing and screws actuated by a 15-h.p. Crocker-Wheeler motor. This motor is reversible, and runs at a constant speed. It is supplied with current at 240 volts, while the motor which revolves the lower rolls is supplied from a four-wire multiple voltage system. These



MOTOR DRIVEN BENDING ROLLS.

bending rolls measure 12 ft. 2 in. between the housings, and will handle ⅞-in. plates.

## MR. WALDO H. MARSHALL.

Mr. Waldo H. Marshall has resigned the position of general manager of the Lake Shore & Michigan Southern Railway, to accept the presidency of the American Locomotive Company.

Mr. Marshall served an apprenticeship with the Rhode Island Locomotive Works, after which he entered the drafting room, and soon became chief draftsman. Later he spent some time in New York as consulting mechanical engineer. In January, 1888, he went to Chicago as editor of the *Railway Review*. Three years later he became editor of the *Railway Master Mechanic*. During 1896 and the early part of 1897 he edited the AMERICAN ENGINEER AND RAILROAD JOURNAL with Mr. M. N. Forney. In June, 1897, he was appointed assistant superintendent of motive power of the Chicago & Northwestern. Two years later he was called to the position of superintendent of motive power of the Lake Shore & Michigan Southern Railway. From February, 1902, to July, 1903, he was general superintendent of the same road, also of the Lake Erie & Western and the Indiana, Illinois and Iowa. Since July, 1903, he has been general manager of these roads. From apprentice in a small locomotive works to the presidency of the largest locomotive company, although Mr. Marshall is not yet 42 years of age, is indeed a remarkable rise. His thorough technical education is the result of individual study. His success is probably in large measure due to honesty, personal ability, breadth of view and to the fact that he has the faculty of being able to develop and surround himself with capable and loyal subordinates.

## PERSONALS.

Mr. J. R. Alexander has been appointed general road foreman of engines of the Pennsylvania Railroad at Altoona, Pa.

Mr. W. J. Rusling has been appointed assistant to the assistant engineer of motive power at Altoona, Pa.

Mr. William Elmer, Jr., assistant engineer of motive power at Altoona, has been appointed master mechanic of the Pittsburgh shops, to succeed Mr. Thomas.

Mr. W. B. Ott, assistant engineer of motive power at Buffalo, N. Y., has been transferred to Altoona, Pa., in a similar capacity, succeeding Mr. W. Elmer, Jr., promoted.

Mr. S. G. Thomson has been appointed assistant engineer of motive power of the Buffalo & Allegheny Valley division of the Pennsylvania Railroad at Buffalo, N. Y., succeeding Mr. W. B. Ott, transferred.

Mr. I. B. Thomas, master mechanic of the Pittsburgh shops of the Pennsylvania Railroad, has been appointed master mechanic of the shops at Altoona, Pa., in place of Mr. G. W. Strattan, retired under the pension rules, having reached the age of 70 years.

Mr. M. J. McCarthy has been appointed division master mechanic of the Lake Shore & Michigan Southern Railway at Elkhart, Ind., succeeding Mr. Cross, transferred.

Mr. C. W. Cross, division master mechanic of the Lake Shore & Michigan Southern Railway at Elkhart, Ind., has been appointed to the newly created position of superintendent of apprentices, with headquarters at New York.

Mr. George Dickson has been appointed master mechanic of the Chicago, Cincinnati & Louisville Railroad, with office at Peru, Ind.

Mr. H. J. Beck, road foreman of engines of the Philadelphia & Reading Railway, has been appointed general locomotive inspector, with office at Reading, Pa.

Mr. G. G. Davis has been appointed general foreman of the car department of the Cleveland, Cincinnati, Chicago & St. Louis Railway, at Indianapolis, Ind.

Mr. L. L. Bentley has resigned as mechanical engineer of the Lehigh Valley Railroad to become vice-president and general manager of the Oswego Boiler & Engine Company, of Oswego, N. Y.

Mr. J. N. Mallory, formerly in the department of tests of the New York Central, has been appointed mechanical engineer of the Lehigh Valley Railroad, succeeding Mr. L. L. Bentley, resigned.

Mr. W. N. Cox, superintendent, has been appointed superintendent of transportation and machinery of the Atlanta & West Point Railway, with office at Montgomery, Ala. The office of superintendent has been abolished.

Mr. D. J. Malone, division master mechanic of the Oregon Short Line at Salt Lake City, Utah, has been appointed division master mechanic of the Southern Pacific Railway at Ogden, Utah, to succeed Mr. E. M. Luckett, resigned.

Mr. W. C. Smith, master mechanic of the Missouri Pacific Railway at Fort Scott, Kan., has been transferred to Kansas City, Mo., in a similar capacity, to succeed Mr. William Naughton, resigned.

Mr. M. J. McGraw, heretofore master mechanic of the Illinois Central Railway at Clinton, Ill., has been appointed master mechanic of the Missouri Pacific Railroad, at Fort Scott, Kan., succeeding Mr. W. C. Smith.

Mr. L. E. Hassner, heretofore general foreman of shops of the Illinois Central at East St. Louis, Ill., has been appointed master mechanic at Clinton, Ill., succeeding Mr. M. J. McGraw, resigned.

Mr. George W. Little, assistant treasurer of the Pittsburgh Spring & Steel Company, died on Friday, February 16th, of pneumonia, after an illness of one week. Mr. Little had a long experience in the spring business, having been originally connected, in the accounting department, with A. French & Company some thirty years ago, and continued with that company and its successors until 1902, when he became assistant treasurer of the Pittsburgh Spring & Steel Company, which position he held at the time of his death. His long experience in the spring business made him a valuable member of the company, and his death will be a great loss, not only to his immediate associates, but also to the community in which he was held in high esteem.

HEAVY TONNAGE OF STEEL FOR CARS.—From competent authority we have the estimate that between 1,300,000 and 1,400,000 tons of rolled and forged steel will be required for the steel car works output of 1906, and when to shapes and axles are added the requirements in foundry products—malleables, steel castings and car wheels—it may be reckoned that 1,800,000 to 1,900,000 tons of iron and steel will be consumed by this single industry in the present year, a source of demand that was scarcely regarded as a factor seven years ago. Already rapidly approaching the wire and wire nail industries in its requirements of iron and steel, the steel car industry is pushing forward at a rate that one day may bring its tonnage abreast of that entering into steel rails.—*The Iron Age.*

REAMING CORED HOLES VS. DRILLING.—Actual practice determines a hole can be properly reamed for one-half what it costs to drill; therefore, if a hole must needs be exact in location and size, first core it as large as practice will permit, then finish with a reamer.—*Mr. C. J. Crowley, Western Railway Club.*

# BOOKS.

Locomotive Tests and Exhibits, Pennsylvania Railroad System, Louisiana Purchase Exhibition, 1904, 727 pages. Published by the Pennsylvania Railroad Co. D. S. Newhall, Purchasing Agent, Broad Street Station, Philadelphia, Pa. Price, $5.00.

An extended review of this book will be found on page 90 of this issue.

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Foundations and Setting Machine Tools. Published under the direction of the engineering bureau of the Niles-Bement-Pond Company, 111 Broadway, New York.

This is a small pamphlet of 12 pages containing a number of important notes concerning the construction of foundations for machine tools and the setting of machines.

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The Science Year Book. Edited by Major B. F. S. Baden-Powell. Published by King, Sell & Olding, Ltd., 27 Chancery Lane, W. C., London, England. Standard, 6 by 9 in. size. Price, 5s.

The first 208 pages are devoted to astronomical, physical and chemical notes and tables, to summaries of progress in science and to various directories, etc. The remainder of the book, about 375 pages, is reserved for a diary.

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Master Car Builders' Association. Proceedings of the thirty-ninth annual convention held at Manhattan Beach, N. Y., June, 1905. Edited by the Secretary, Mr. J. W. Taylor, Old Colony Building, Chicago, Ill.

The association standards, recommended practice, interchange rules, reports of the arbitration committee and the convention proceedings, constitute a volume of 575 pages, and in addition there are a large number of folded plates used in connection with the committee reports and also showing the association standards.

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Proceedings of the International Railroad Master Blacksmiths' Association. Thirteenth Annual Convention, held at Cleveland, August, 1905. Edited by A. L. Woodworth, Secretary, Lima, Ohio.

These proceedings are specially interesting and valuable and should be in the hands of all those interested in this work. Among the more important subjects considered were oil furnaces, treatment of high-speed steel, repairing locomotive frames, forging motion work, dies and formers for forging machines, tools and formers for steam hammers, and the ideal blacksmith shop.

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Machine Shop Arithmetic. By Fred H. Colvin and Walter Lee Cheney. Fourth Edition. 1905. 144 pages; 4 by 6 ins. Flexible cover. Published by the Derry-Collard Company, 256 Broadway, New York. Price, fifty cents.

The fact that it was necessary to issue a 4th edition of this little work, indicates that it has met a real need. It considers problems which often come up in the machine shop, and not only are rules presented for their solution, but explanations are given in clear and simple language, as to why each step is taken. Additions to this edition include metric threads and tables for force and running fits.

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Tests of High Speed Tool Steels on Cast Iron. By L. P. Breckenridge and Henry B. Dirks. Published by the University of Illinois Engineering Experimental Station, Urbana, Ill.

This is the second bulletin on high speed steels. The first one gave a brief account of the development of these steels, announced the series of tests to be made and presented tabulated results of the most important tests which had been made by various authorities. Bulletin No. 2 describes an extensive series of tests made at the engineering experiment station of the University of Illinois, during the past year, with the high speed tool steels cutting cast iron. The summary of results is very interesting and valuable and is partially reproduced on another page of this issue. The bulletin closes with a list of the leading articles which have been published on high speed steels. Copies of this bulletin may be obtained from the Engineering Experimental Station, Urbana, Ill.

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Electric Wiring, Diagrams and Switchboards. By Newton Harrison. Published by the Norman W. Henley Publishing Company, 132 Nassau Street, New York. 1906. 272 pages, 105 illustrations. Price, $1.50.

This is a practical treatise on the theory and design of wiring circuits. It is well illustrated, and, although it is a technical work the underlying principles of wiring are presented in language suited to the comprehension of the general reader. The fundamental principles of wiring are first considered, and after their application to a simple circuit has been thoroughly presented the more complex types of circuits are carefully considered. Several chapters are devoted to moulding and conduit work. It also contains several chapters on the design of switchboards for lighting and power, and considerable space is devoted to the consideration of alternating current circuits. The calculations and examples in the treatment of both direct and alternating current are limited to the use of simple arithmetic.

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Proceedings of the Railway Signal Association for the Year 1905. Volume 8. Published by the Association, 335 Madison Avenue, New York City. 360 pages. Price twenty-five cents.

This volume contains the individual papers, committee reports and discussion of the two New York meetings, two Chicago meetings, and the annual meeting held at Niagara Falls in October. Among the more important subjects considered were the use of the storage battery in connection with signals; signalling in the New York subway; standard specifications for mechanical interlocking and material for construction work (these standards were adopted at the October meeting); discipline of trainmen as relating to automatic block signals; the semaphore spectacle, the cost of stopping trains compared with the cost of maintenance, operation and inspection of interlocking plants; circuits for manual block signal system; organization of the signal department; copper-covered wire for signal purposes; circuits for automatic block signals for steam and electric roads; signal lamps, designs, oil used, care of, etc.; observations on signal lenses; the roundel problem; railway telephone service (cost of line construction).

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Proceedings of the Traveling Engineers' Association. Thirteenth Annual Convention, held at Detroit, September, 1905. Edited by Mr. W. O. Thompson, Secretary, Oswego, N. Y. 328 pages.

This report is a very forcible indication of the flourishing condition of the association and should be in the hands of all those who are interested in locomotive operation and maintenance. It includes committee reports and discussions of the following subjects. Is the third man necessary on the large type of modern locomotives; if so, in what capacity? Grease as a lubricant for all bearings on a locomotive. What devices for and arrangement of engines and tenders will lighten the work of the engineer and firemen? Bell ringers, air sanders and other devices operated by compressed air; their care and arrangement to get the best results. The following individual papers were presented and discussed: Electric motors and instructing the men to handle them, by E. F. Miller. Injectors: modern practice, by S. L. Kneass. The latest makes of lubricators; their operation and maintenance, by C. B. Conger. The mechanical stoker, by C. A. Kraft. The piston versus the slide valve, by L. S. Allen.

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Biographical Directory of Railway Officials of America. Published by the Railway Age Company of Chicago. Cloth bound. 694 pages; 6 by 8½ ins. 1906. Price, $3.00.

It is aimed to present in a concise form the history of the professional careers of the officials of American railroads. It is interesting to note that about 1,200 new sketches have been added which did not appear in the 1901 edition, and about the same number of names have been ommitted because of death, or retirement from the service. The new edition also contains sketches of the personal history of 96 national and state railroad commissioners. It is rather disappointing to find that the names of several important railway officials have been omitted, but this is possibly due to a lack of co-operation on the part of the officials. Of the 5,000 names mentioned 440, or 9.05 per cent., represent the engineering department and only 270 or 5.5 per cent., are officials of the mechanical departments. master mechanics, or higher. It would seem that the relative importance of the mechanical department is such as to warrant a considerably larger number of names. A careful examination indicates that while some master mechanics are mentioned there are a number who are widely known who are not mentioned, and there are a number of motive power officials who have considerably more authority than some of the master mechanics mentioned who really deserve a place and it is hoped that in future editions the selection will be more carefully made. In spite of this deficiency the volume is a valuable one and is an indispensable reference book in every railway library. It is no small task to have gathered this large amount of information together and arranged it properly, and the publishers are to be congratulated upon the results of their labors.

## CATALOGS.

IN WRITING FOR THESE CATALOGS PLEASE MENTION THIS PAPER.

ELECTRIC GENERATORS.—Bulletin No. 63 from the Crocker-Wheeler Company, Ampere, N. J., presents an extensive list of the users of their direct current engine type generators.

ROOFING RULES.—A handbook on sheet metal in building construction issued by the Merchant & Evans Company, Philadelphia, Pa. The latter part of the booklet contains instructions as to the construction and application of metal roofs.

ARC LIGHTING APPARATUS.—A 40 page bulletin, No. 4428, from the General Electric Company, Schenectady, N. Y., is devoted entirely to the consideration of their various types of arc lamps, light diffusing devices and auxiliary apparatus.

VARIABLE SPEED MOTORS.—Bulletin No. 4430, from the General Electric Company considers the advantages of variable speed motors for use in connection with machine tool drives and illustrates several types of motors and controllers which are recommended for this class of work.

RADIAL DRILLS.—The 1906 catalog of the Fosdick Machine Tool Company, Cincinnati, O., has just been received. It contains an illustrated description of the different lines of radial drills and horizontal boring, drilling and milling machines made by them. Several pages are devoted to motor applications to their radial drills.

HYDRAULIC JACKS.—Sectional catalog No. 86, from the Watson-Stillman Company, New York, describes the various types of hydraulic jacks and auxiliary apparatus made by them. Some of the features illustrated for the first time are the low type journal box jacks; pipe pulling, ring, wedges and faces; bridge transfer jacks used for adjusting ferry bridges to the locking level of car floats and the jack repair vise.

HOLLOW STAY BOLTS.—The Falls Hollow Stay Bolt Company, Cuyahoga Falls, Ohio, are sending out a pamphlet which contains a reprint of a paper on "Coal; its uneconomic use and abuse, generally by steam makers but especially by the railroads, and how to save 50 per cent.," which was presented before the St. Louis Railway Club and also a paper presented before the New York Railroad Club, on "The Quality and Utility of Solid, Flexible and Hollow Staybolts in Iron and Copper." Both of these papers were written by Mr. John Livingstone.

FOUR-CYLINDER BALANCED COMPOUNDS.—This is the title of a pamphlet issued by the American Locomotive Company, containing a paper read before the Railway Club of Pittsburgh, by Mr. F. J. Cole, mechanical engineer. It opens with a discussion of the advantages of this type of locomotive and its development is considered from its earliest stages to the present time. A number of diagrams from early patent specifications are presented. The different forms of crank axles are also illustrated and considered. Several engravings illustrating the more well known English, French and American four-cylinder compounds are presented and the Cole system receives prominent mention.

CALENDARS FOR 1906.—Attractive calendars have been received from the Falls Hollow Staybolt Company, Cuyahoga Falls, O.; H. B. Underwood & Co., Philadelphia, Pa.; The Jeffrey Manufacturing Company, Columbus, O.; Greene, Tweed & Co., 17 Murray street, N. Y., manufacturers of Palmetto packing; Star Brass Manufacturing Company, Boston, Mass.; Cleveland Pneumatic Tool Company, Cleveland. On the Falls Hollow Staybolt calendar is a copy of A. G. Gow's famous painting entitled "Washington's Farewell to His Generals." The Cleveland Pneumatic Tool Company's calendar has a splendid reproduction of a beautiful painting by A. Asti.

LATHES.—Catalog "R" has just been issued by the Lodge & Shipley Machine Tool Company, Cincinnati, O. The details of their improved engine lathes are illustrated and described, and the various sizes of these lathes, from 14 to 48 ins., are illustrated and tables of their leading dimensions are presented. A 24-in. turret chucking lathe, a 24-in extra heavy screw machine and a combination 24-in. turret engine lathe are also illustrated. Several pages are devoted to a description of the patent head lathe and tables of dimensions of the various sizes of this line of lathes are given. The various attachments, which are not regularly furnished with the lathes, are described and several typical motor applications are shown.

DETROIT LOCOMOTIVE LUBRICATORS.—The Detroit Lubricator Company, Detroit, Michigan, has just published a pamphlet descriptive of their new type of locomotive lubricator represented by the "Detroit" No. 21. This lubricator occupies 25 per cent. less space in the cab and has 40 per cent. less parts, 35 per cent. less varieties of parts and 85 per cent. less metal joints than the older type of lubricator. It has a sight feed glass that will not break and the oil is maintained at a uniform temperature and will not chill. The pamphlet considers the advantages of this new type, describes its construction and gives directions for operating it. A number of pages are devoted to helpful hints and other information which will prove of considerable interest and value to those interested in this subject.

GAS ENGINES.—The Westinghouse Companies' Publishing Department has issued reprints of two important pamphlets; one of them, No. 1017, contains an article on "Notes on the Design of Large Gas Engines With Special Reference to Railway Work," by Mr. Arthur West, and also a paper on the "Application of Gas Power to Electric Railway Service," by Mr. J. R. Bibbins. Both of these papers were presented before the American Street and Interurban Railway Association at the Philadelphia Convention, September, 1905. Bulletin No. 1018 contains a reprint of an article, which appeared in *Cassier's Magazine*, on "Gas Power for High Pressure City Fire Service." This article, by Mr. J. R. Bibbins, considers the Philadelphia high pressure pumping station.

## NOTES.

GREENE, TWEED & COMPANY.—In order to accommodate their growing business this company has found it necessary to remove to larger quarters at 109 Duane St., New York City.

H. W. JOHNS-MANVILLE COMPANY.—The increasing business of this company has made necessary the establishment of two new departments at the main offices in New York; one of these, known as the railroad department, has been placed in charge of Mr. J. E. Meek. An export department has been organized, under the management of Mr. Wm. Angevine, in order to facilitate the handling of the large foreign business.

CHICAGO PNEUMATIC TOOL COMPANY.—Mr. Wilbur H. Traver, connected with the Rand Drill Company for twelve years, as manager of the Chicago territory and as manager of the railroad department of the Ingersoll-Rand Drill Companies, has taken a position with the above company as manager of their mining and contract departments. He will devote his time principally to the sale of air compressors, rock drills and mining machinery.

RAILWAY APPLIANCES COMPANY.—This company announces that is has purchased and will operate the business of Pedrick & Ayer, at Plainfield, N. J., also that it has taken the sales agency for the Elastic Nut, manufactured by the National Elastic Nut Company of Milwaukee, Wis. Mr. Sheldon E. Bent, who for the past six or seven years has been superintendent of transportation of the Oceanic, of Mexico, and general superintendent of the Vera Cruz and Pacific, will hereafter be connected with the track department.

WM. B. SCAIFE & SONS COMPANY.—This company, of Pittsburgh, announces that they have secured the following contracts: A structural steel boiler house for the Washington Coal & Coke Company, Star Junction, Pa. The construction and erection of steel frame buildings required by the Firth-Sterling Steel Company for their new ordnance plant at Washington, D. C. A large amount of structural steel work to be used in connection with the new plant of the New York State Steel Company at Buffalo, N. Y.

CHICAGO PNEUMATIC TOOL COMPANY.—The annual report to the stockholders of this company indicates a very satisfactory condition of affairs. In addition to the 4 per cent. dividend for the year, $315,134.39 has been carried to the surplus account as additional working capital, required on account of the enlarged scope of operations and the increased volume of business. During the past year the Consolidated Pneumatic Tool Company, Ltd., of London, has been developing the organization of the Fraserburgh plant in Scotland, until it is at the present time running to its full capacity. The International Compressed Air & Electric Company, Berlin, has been organized. The Philadelphia Pneumatic Tool Company of Philadelphia has been acquired, as has also the business and plant of the Canadian Pneumatic Tool Company, Ltd., of Montreal, Canada.